United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
North Dakota Agricultural
Experiment Station, North
Dakota Cooperative
Extension Service, and
North Dakota State Soil
Conservation Committee

Soil Survey of Barnes County, North Dakota

How To Use This Soil Survey

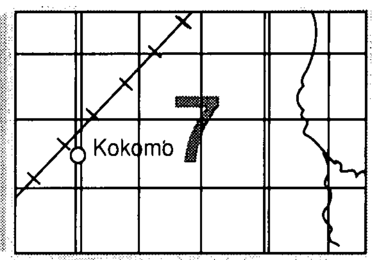
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

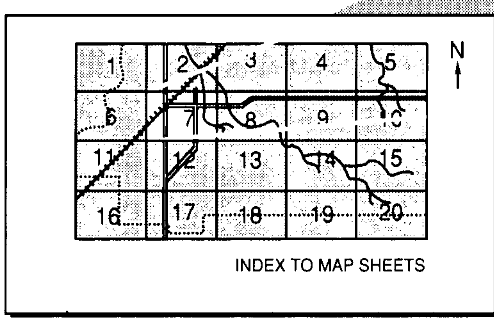
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



MAP SHEET

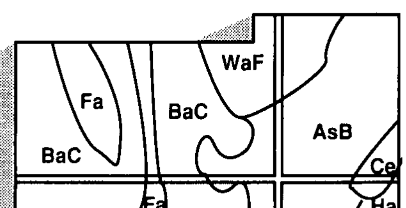
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.

MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1987. Soil names and descriptions were approved in 1988. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1987. The flight for the photo base was in 1976. This survey was made cooperatively by the Soil Conservation Service and the North Dakota Agricultural Experiment Station, the North Dakota Cooperative Extension Service, and the North Dakota State Soil Conservation Committee. Financial assistance was provided by Barnes County Soil Conservation District and the North Dakota Department of University and School Lands. It is part of the technical assistance furnished to the Barnes County Soil Conservation District.

Cover: A windbreak in an area of Overly and Bearden soils.

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Issued June 1990

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Foreword

This soil survey contains information that can be used in land-planning programs in Barnes County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Ronnie L. Clark
State Conservationist
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Soil Survey of Barnes County, North Dakota

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United States Department of Agriculture, Soil Conservation Service,
in cooperation with
North Dakota Agricultural Experiment Station, North Dakota Cooperative Extension Service, and North Dakota State Soil Conservation Committee

Barnes County is in the southeastern part of North Dakota (fig. 1). It has a total area of 956,800 acres, or 1,495 square miles. Of this acreage, 13,790 acres is water. Most of the water area is Lake Ashtabula and numerous small lakes in the western part of the county. Valley City, the county seat, is in the central part of the county.

This soil survey updates the survey of Barnes County published in 1912 *(7)*. It provides additional information on use of the soils, and the maps show the soils in greater detail.

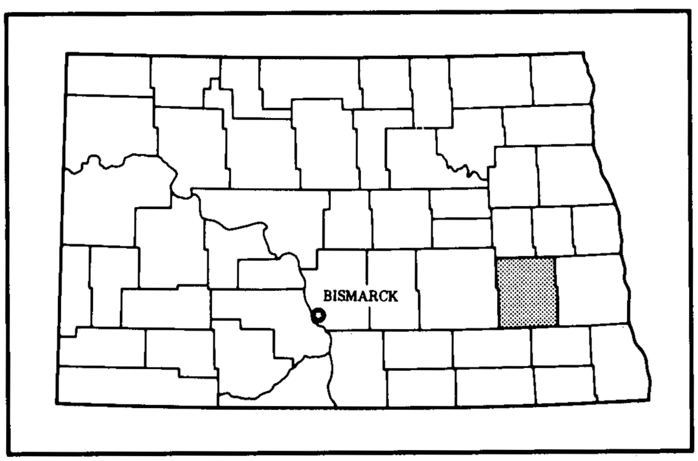

Figure 1.—Location of Barnes County in North Dakota.

General Nature of the County

This section provides general information about the county. It describes climate, history and development, transportation, farming, natural resources, and physiography, relief, and drainage.

Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

Barnes County is usually quite warm in summer and is characterized by frequent spells of hot weather and occasional cool days. It is very cold in winter, when Arctic airmasses frequently surge over the area. Most precipitation falls during the warm period and is normally heaviest late in spring and early in summer. Winter snowfall is normally not too heavy, and the snow

is blown into drifts so that much of the ground is left free of snow.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Valley City in the period 1951 to 1984. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 11 degrees F, and the average daily minimum temperature is 0 degrees. The lowest temperature on record, which occurred at Valley City on January 29, 1965, is -40 degrees. In summer the average temperature is 67 degrees, and the average daily maximum temperature is 80 degrees. The highest recorded temperature, which occurred at Valley City on July 12, 1973, is 102 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 18 inches. Of this, about 14 inches, or more than 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 11 inches. The heaviest 1-day rainfall during the period of record was 3.8 inches at Valley City on August 21, 1964. Thunderstorms occur on about 32 days each year.

The average seasonal snowfall is about 31 inches. The greatest snow depth at any one time during the period of record was 34 inches. On the average, 47 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 65 percent of the time possible in summer and 45 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 14 miles per hour, in spring.

Several times each winter, storms accompanied by snow and high winds bring blizzard conditions to the area. Hail during summer thunderstorms occurs in small, scattered areas.

History and Development

Among the first known inhabitants of the area were the Sioux Indians. They made small camps along the Sheyenne River. The river furnished water for drinking, wooded cover along the banks attracted game and supplied firewood, and the moist bottom land provided tillable soil *(16)*. In the late 1700's and early 1800's fur traders, government exploratory expeditions, and hunting parties entered the area. A campsite used frequently by these early inhabitants is now known as Clausen Springs *(3)*.

By the mid-1800's the fur trade had started to decline as a result of the smallpox epidemic of 1837, which had greatly reduced the Indian population. Red River Metis, who were trappers or traders and gold seekers crossing the plains, greatly reduced the amount of game available. The Indian wars in the 1860's followed by reservation life brought the fur trade to a close *(16)*.

When the Northern Pacific Railroad reached and crossed the Sheyenne River in the fall of 1872 at what is now Valley City, the settlement of Barnes County began. Barnes County was organized in August 1878. It was originally called Burbank County, named after John A. Burbank, Governor of Dakota Territory from 1869 to 1874. An act of the Dakota Legislature in 1874, however, changed the name to Barnes County in honor of Alphonso H. Barnes, who was an associate justice of Dakota Territory at that time *(11)*.

Initial settlement of the county was largely confined to the Sheyenne River Valley, mostly in the area adjacent to Valley City. Most of the earlier settlers were of Irish, Scotch, or English extraction. Many were former residents of Canada. One of the most important of these settlers was Hiram Walker, a flour miller. The establishment by Walker and his sons of several flour and grist mills on the Sheyenne River contributed greatly to the economic well being of the county residents *(3)*.

The population of Barnes County was 1,585 in 1880 *(7)*. By 1910 the population had grown to 18,066. It remained near this level until 1930, when it began to decline because of drought and depression. By 1980 the population was 13,960 *(12)*.

Valley City, the largest town in the county, had a population of 7,774 in 1980. Other communities in the county include Dazey, Wimbledon, Pillsbury, Leal, Rogers, Sanborn, Eckelson, Oriska, Fingal, Litchville, Hastings, Kathryn, Sibley, and Nome. The North Dakota Winter Show has been held annually at Valley City

since 1938. It has grown to be one of the Upper Midwest's largest agricultural expositions. A distinguishing landmark at Valley City is High Line Bridge, which crosses the Sheyenne River Valley. This trestle bridge was completed in 1908. Prior to construction of this bridge, engines were used to push heavy trains up the steep grade of the Sheyenne River Valley.

Transportation

One federal highway and five state highways provide access to markets. Interstate 94 and North Dakota Highways 9, 26, and 46 are major east-west routes across the county. North Dakota Highways 1 and 32 are major north-south routes. These state and federal highways along with the hard surfaced and graveled county and township roads provide a good transportation network. The nearest major commercial airline facilities are in adjacent Cass County to the east. Valley City has an airport for small light planes. The county is also served by a bus line and two railroads.

Farming

The development of farming progressed rapidly throughout Barnes County from 1880 to 1900. In 1950 the county had 1,893 farms. From 1950 to 1982 the number of farms declined to 1,015 *(12)*. The Barnes County Soil Conservation District was established in 1948.

The main crop in Barnes County is wheat. Other important crops are sunflowers, barley, oats, grass-legume hay, flax, and corn. Sunflowers have been an important crop in the last decade. They are grown mostly for oil production. Barley is grown for feed and malting. Most of the corn is harvested for grain.

In 1984 about 88 percent of the county was cropland, 6 percent was range and pasture, 1 percent was water, and 5 percent was woodland, federal and state land, and other land *(5, 20)*.

Compared to growing cash crops, raising livestock is a small enterprise in the county, but it is an important source of income for some farmers. On January 1, 1985, there were 31,000 cattle, 12,500 hogs, and 5,300 sheep on farms in the county *(5)*.

Natural Resources

Soil provides a medium for crops and the grasses grazed by livestock. Other important natural resources in the county are sand, gravel, and water.

As a result of glaciation, there are areas of sandy and gravelly material suitable for commercial excavation. Onsite investigation is needed because the quality of the deposits varies. Excess silt or clay content is a common limitation for the use of these deposits. A high shale content also limits the use of these deposits.

The Spiritwood aquifer is the most important water-bearing deposit in the county. It is in the western part of the county. Other important aquifers are the Stoney Slough, the Sand Prairie, and the Valley City.

Sufficient water for irrigation is available from several aquifers in the county. The Spiritwood aquifer offers the greatest potential, and it is probable that the Sand Prairie and Stoney Slough aquifers locally would yield adequate quantities of water for small irrigation projects *(9)*.

Physiography, Relief, and Drainage

Barnes County is in the Drift Prairie section of the Central Lowland province of the Interior Plains *(6)*. The dominant physiographic features of the county are the two major belts of end moraines and the deep Sheyenne River Valley.

The Kensal-Oakes end moraine extends across Barnes County from Wimbledon south-southeast toward Kathryn. The Luvern end moraine crosses Barnes County in a north-south direction just east of and generally parallel with the Sheyenne River. This end moraine forms a high elongated belt locally called the Alta Ridge *(9)*. The relief of the Luvern is greater than that of other moraines in the county. These features, in general, are separated by broad, undulating plains of ground moraine. Nearly all of the area is mantled with glacial drift. The uplands are covered with glacial till, glacial lacustrine sediment, kames, eskers, drumlins, and glacial outwash sediment.

Most of the glacial lacustrine sediment in Barnes County is on the Glacial Lake Lanona Plain. During glacial times, the Sheyenne River was blocked by ice about 12 miles south of Valley City and a large shallow lake called Lake Lanona was created. Lake Lanona extended north along the Sheyenne River Valley into Griggs County and covered about 160 square miles at its maximum extent. The lake sediment is generally well sorted, laminated, calcareous silt and clay *(10)*.

The largest outwash system in Barnes County is called Stoney Slough. The Stoney Slough channel extends southeastward from the west-central part of the county and widens to form another outwash plain, locally known as the Sand Prairie, which extends south into Ransom County. Most of the Sand Prairie outwash

plain was deposited when Glacial Lake Lanona drained into the Stoney Slough outwash system *(10)*.

Bedrock is exposed in the valleys of the Sheyenne River and the Bald Hill Creek. The flood plains of these and other streams are blanketed by alluvium. In places the undulating moraines merge into a series of slightly lower, flat terraces along the Sheyenne River Valley. Elevation ranges from about 1,080 feet on the flood plain of the Sheyenne River south of Kathryn to about 1,570 feet on the crest of an end moraine north of Valley City *(10)*.

The principal streams in Barnes County are the Sheyenne River, the Maple River, the Bald Hill Creek, and the Stoney Slough Creek. The Sheyenne River flows southward through the central part of the county and is entrenched in a valley about 2 miles wide and 150 feet deep. It is the main water course in Barnes County. The Maple River flows through the extreme northeast corner of the county and, along with its tributaries, drains the eastern one-fourth of Barnes County. The Bald Hill Creek is in the north-central part of the county, west of the Sheyenne River. It drains into the Sheyenne River and Lake Ashtabula.

Baldhill Dam, constructed across the Sheyenne River, is about 12 miles north of Valley City. It was completed in 1950. The body of water impounded by Bald Hill Dam is called Lake Ashtabula, an Indian term meaning "fish river." The lake covers about 5,430 acres and extends northward into Griggs County. It supplies water in times of low water flow to communities downstream. The lake also stores runoff from spring snowmelt and rainstorms, which helps to protect downstream communities from flooding. In addition, it provides opportunities for fish and wildlife management and water recreation in an area with few lakes.

The Stoney Slough Creek drains some of the southwest part of the county. It empties into the Sheyenne River near the town of Kathryn.

All of the streams drain to the Red River of the North and eventually empty into Hudson Bay. The Continental Divide, which separates the Gulf of Mexico and Hudson Bay drainageways, crosses the western part of Barnes County. Areas to the west of the Divide drain into the James River, which eventually empties into the Gulf of Mexico.

Most of the county does not have an integrated drainage system. Numerous potholes, sloughs, and small lakes serve as collecting places for runoff on the end moraines and ground moraines.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, soil reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify

soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are named in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Survey Procedures

The general procedures used to make this survey are described in the *National Soils Handbook* and the *Soil Survey Manual (17)*. The *Major Soils of North Dakota (14)*, the *Geology and Ground Water Resources of Barnes County, North Dakota (10)*, the general soil map of Barnes County, *County General Soil Maps, North Dakota (15)*, and the *Soil Survey of Barnes County, North Dakota (7)* are among the references used.

Traverses were made on foot, by truck, or by all-

terrain motorcycles at an interval close enough to locate contrasting soil areas of about 3 acres. All map units were characterized by transects in representative units. One transect was required for each 1,000 acres of the unit mapped, with a minimum of two and a maximum of about ten. Data collected from the transects were analyzed statistically and used to justify names and establish the range of composition of each map unit. The statistical method used a 90 percent confidence interval estimate of the mean map unit composition percentage. This method predicts with a 90 percent confidence level that the average composition in the county for a map unit will fall in the given range of percentages.

The range of average composition of most of the map units complexes is not wide; however, the Kloten-Buse complex, 9 to 35 percent slopes, has a wide range of average composition because of the greater variability in the kinds of soil in this unit.

Each soil map unit has a minimum documentation of one to three pedon descriptions for each soil series used in its name. During the survey, soil samples were collected on five pedons for characterization. The samples were analyzed by the North Dakota State University Soil Characterization Laboratory. An additional nine pedons were sampled and analyzed by the North Dakota State Highway Department laboratory.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Some of the boundaries and soil names on the general soil map of Barnes County do not match those on the maps of Cass and Lamoure Counties. The differences are a result of improvements in the classification of soils, particularly in modification or refinements in soil series concepts. Also, there may be differences in the intensity of mapping or in the extent of the soils within the survey area.

Soil Descriptions

Level to Steep, Loamy Soils on Glacial Till Plains and Moraines

These soils formed in glacial till. They make up about 46 percent of the county. In most areas runoff flows into drainageways and streams, but in some areas it collects in shallow depressions. A few marshes and depressions are in most areas. The soils are suited to cultivated crops and hay and are well suited to range and pasture.

1. Barnes-Buse-Svea Association

Deep, undulating to steep, well drained and moderately well drained, medium textured soils

This association is on knolls, summits, shoulder slopes, side slopes, and foot slopes and in swales on till plains and moraines. Runoff flows into streams. Slope ranges from 3 to 35 percent.

This association makes up 4 percent of the county. It is about 46 percent Barnes soils, 31 percent Buse soils, 17 percent Svea soils, and 6 percent soils of minor extent.

The undulating to hilly, well drained Barnes soils are on side slopes. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 22 inches thick. In sequence downward, it is very dark grayish brown, dark brown, dark grayish brown, and grayish brown. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

The undulating to steep, well drained Buse soils are on knolls, summits, and shoulder slopes. Typically, the surface layer is black loam about 6 inches thick. The subsoil is loam about 15 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The next layer is grayish brown, mottled loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled loam.

The undulating, moderately well drained Svea soils are on foot slopes and in swales. Typically, the surface soil is black loam about 12 inches thick. The subsoil is loam about 31 inches thick. In sequence downward, it is very dark brown, very dark grayish brown, grayish brown and mottled, and light brownish gray and mottled. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Hamerly, Parnell, and Southam are the minor soils in this association. The somewhat poorly drained Hamerly soils are on flats. They have accumulated lime in the subsoil. The very poorly drained Parnell and Southam soils are in deep depressions. Parnell soils have a silty

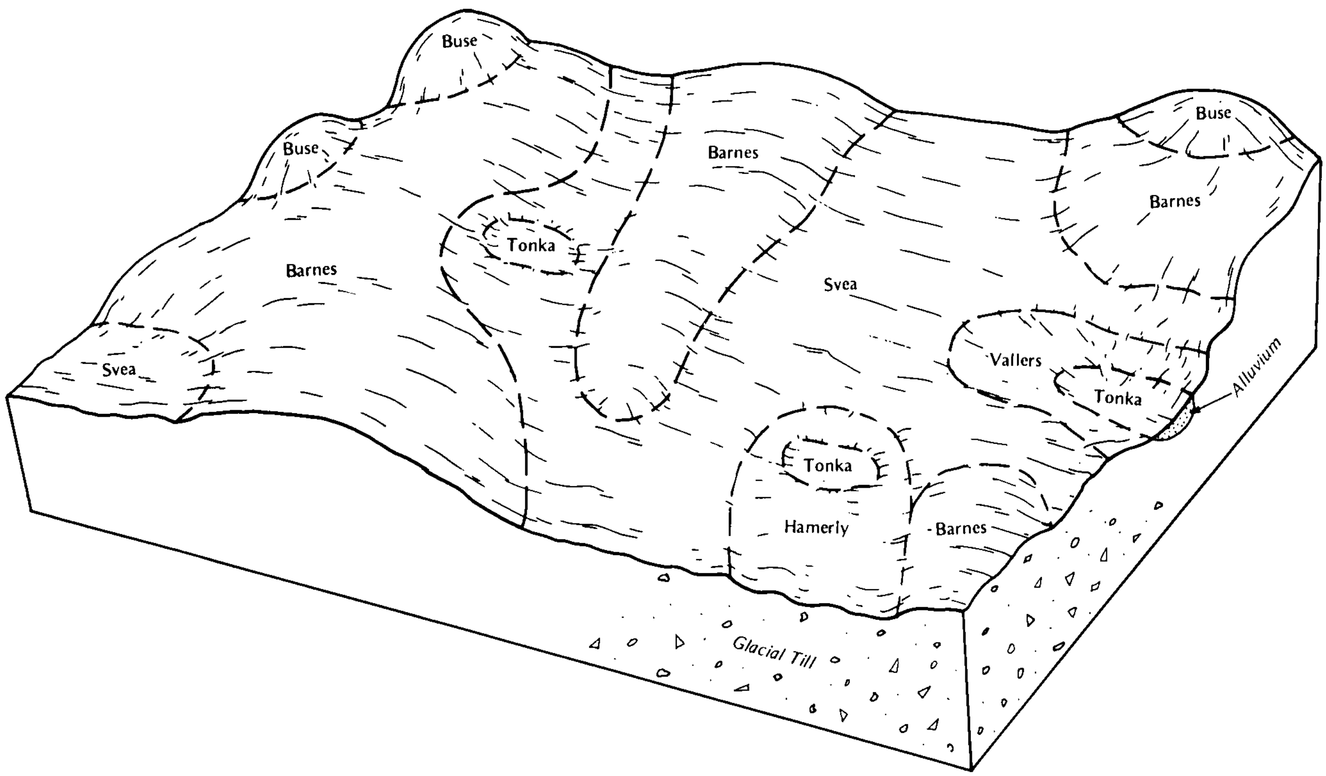

Figure 2.—Typical pattern of soils and parent material in the Barnes-Svea-Buse association.

clay loam surface layer and have accumulated clay in the subsoil. Southam soils have an organic surface layer.

Most areas of this association are used for cultivated crops; however, the hilly and steep soils are used mostly for range. The gently rolling and rolling soils are suited to small grain. The hilly and steep soils are best suited to range. The main concern in managing cultivated crops is controlling water erosion and soil blowing. The main concerns in managing range are maintaining an adequate cover of the important forage plants and achieving a uniform distribution of grazing.

The main limitations on sites for septic tank absorption fields are the slope and moderately slow permeability. The main limitations on building sites are the shrink-swell potential and the slope.

2. Barnes-Svea-Buse Association

Deep, level to rolling, well drained and moderately well drained, medium textured soils

This association is on ridges, knobs, side slopes, summits, and foot slopes and in swales on till plains and moraines. Slopes are short and complex. The landscape is dotted with flats and depressions. Runoff flows mostly into the depressions; however, some flows into streams. Slope ranges from 0 to 15 percent.

This association makes up about 35 percent of the county. It is about 34 percent Barnes soils, 21 percent Svea soils, 11 percent Buse soils, and 34 percent soils of minor extent (fig. 2).

The level to rolling, well drained Barnes soils are on summits and side slopes. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 22 inches thick. In sequence downward, it is very dark grayish brown, dark brown, dark grayish brown, and grayish brown. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

The level to gently sloping, moderately well drained Svea soils are on foot slopes and in swales. Typically, the surface soil is black loam about 12 inches thick. The subsoil is loam about 31 inches thick. In sequence downward, it is very dark brown, very dark grayish brown, grayish brown and mottled, and light brownish gray and mottled. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

The gently sloping to rolling, well drained Buse soils are on knobs and ridges. Typically, the surface layer is black loam about 6 inches thick. The subsoil is loam about 15 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The next layer is grayish brown, mottled loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled loam.

Hamerly, Parnell, Tonka, and Vallers are the minor soils in this association. The somewhat poorly drained Hamerly soils are on flats. They have accumulated lime in the subsoil. The very poorly drained Parnell soils are in deep depressions. They have accumulated clay in the subsoil. The poorly drained Tonka soils are in shallow depressions. They have a leached subsurface layer and have accumulated clay in the subsoil. The poorly drained Vallers soils are on flats adjacent to depressions. They have accumulated lime in the subsoil.

Most areas of this association are used for cultivated crops. The soils are suited to small grain and sunflowers and to range and pasture. The main concerns in managing cultivated crops are controlling water erosion and soil blowing and overcoming wetness in areas of the Parnell, Tonka, and Vallers soils.

The main limitations on sites for septic tank absorption fields are moderately slow permeability and the slope. The main limitations on building sites are the shrink-swell potential and the slope.

3. Svea-Cavour-Barnes Association

Deep, level to undulating, moderately well drained and well drained, medium textured soils

This association is on swells and in swales on till plains. The landscape is dotted by low knolls and ridges, depressions, and flats. Runoff flows into depressions. Slope ranges from 0 to 6 percent.

This association makes up about 7 percent of the county. It is about 28 percent Svea soils, 14 percent Cavour soils, 13 percent Barnes soils, and 45 percent soils of minor extent.

The moderately well drained Svea soils are in swales. Typically, the surface soil is black loam about 12 inches thick. The subsoil is loam about 31 inches thick. In sequence downward, it is very dark brown, very dark grayish brown, grayish brown and mottled, and light brownish gray and mottled. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

The moderately well drained, alkali Cavour soils are in swales. Typically, the surface layer is black loam about 6 inches thick. The subsurface layer is very dark gray loam about 3 inches thick. The subsoil is about 29 inches thick. In sequence downward, it is black, dense clay loam, dark gray clay loam, olive gray loam, and olive, mottled loam. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

The well drained Barnes soils are on swells. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 22 inches thick. In sequence downward, it is very dark grayish brown, dark brown, dark grayish brown, and grayish brown. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Buse, Hamerly, Tonka, and Vallers are the minor soils in this association. The well drained Buse soils are on ridges and knolls. They have a calcareous surface layer and subsoil. The somewhat poorly drained Hamerly soils are on flats. They have accumulated lime in the subsoil. The poorly drained Tonka soils are in shallow depressions. They have a leached subsurface layer. The poorly drained Vallers soils are on flats adjacent to depressions. They have accumulated lime in the subsoil.

Most areas of this association are used for cultivated crops. The soils are suited to small grain, sunflowers, range, and pasture. The main concerns in managing cultivated crops are controlling water erosion and improving root penetration in the dense subsoil of the Cavour soils.

The main limitations on sites for septic tank absorption fields are moderately slow and slow permeability and the wetness. The main limitations for building sites are the shrink-swell potential and the wetness.

Level to Undulating, Loamy and Silty Soils on Glacial Till Plains and in Glacial Outwash Channels

These soils formed in glacial till and in alluvium. They make up about 36 percent of the county. In most areas runoff collects in shallow depressions, but in some areas it flows through constructed drains into drainageways and streams. A few marshes, many depressions and low knolls, and a few ridges are in most areas. The soils are suited to cultivated crops, hay, pasture, and range. The Southam soils are well suited to wetland wildlife habitat.

4. Hamerly-Tonka-Barnes Association

Deep, level to undulating, somewhat poorly drained, poorly drained, and well drained, medium textured soils

This association is on flats and swells and in shallow

depressions and swales on till plains. The landscape is dotted with ridges, knolls, and deep depressions. Runoff flows into the depressions. Slope ranges from 0 to 6 percent.

This association makes up about 35 percent of the county. It is about 36 percent Hamerly soils, 14 percent Tonka soils, 12 percent Barnes soils, and 38 percent soils of minor extent.

The level to undulating, somewhat poorly drained Hamerly soils are on flats. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 30 inches thick. It is grayish brown in the upper part and light olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is light brown, mottled loam.

The level, poorly drained Tonka soils are in shallow depressions. Typically, the surface soil is black silt loam about 13 inches thick. The subsurface layer is dark grayish brown, mottled silt loam about 5 inches thick. The subsoil is about 21 inches thick. It is dark grayish brown clay loam in the upper part; olive gray, mottled clay in the next part; and dark grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is olive gray silt loam.

The well drained, level to undulating Barnes soils are on swells. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 22 inches thick. In sequence downward, it is very dark grayish brown, dark brown, dark grayish brown, and grayish brown. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Buse, Svea, Vallers, and Wyard are the minor soils in this association. The well drained Buse soils are on ridges and knolls. They have a calcareous surface layer, subsoil, and substratum. The moderately well drained Svea soils are in swales. They have a dark surface layer that extends to a depth of more than 16 inches. The poorly drained Vallers soils are on flats adjacent to depressions. They have accumulated lime in the subsoil. The somewhat poorly drained Wyard soils are in swales. They have a dark surface layer that extends to a depth of 16 inches or more and have a mottled subsoil.

Most areas of this association are used for cultivated crops. The soils are suited to small grain and sunflowers and to range and pasture. The main concerns in managing cultivated crops are controlling soil blowing on the Hamerly soils and reducing wetness on the Tonka soils.

The main limitations on sites for septic tank absorption fields are the wetness, slow or moderately slow permeability, and ponding on the Tonka soils. The main limitations on building sites are the wetness, the shrink-swell potential, and the ponding on the Tonka soils.

5. Southam-Vallers Association

Deep, level, poorly drained and very poorly drained, medium textured and moderately fine textured soils

This association is on flats and in deep depressions on glacial till plains and in glacial outwash channels. The landscape is dotted with shallow depressions. Slope is 0 to 1 percent.

This association makes up about 1 percent of the county. It is about 33 percent Southam soils, 29 percent Vallers soils, and 38 percent soils of minor extent.

The very poorly drained Southam soils are in deep depressions. They are subject to ponding. Typically, the surface soil is black and is about 29 inches thick. It has a 2-inch-thick cover of organic material. It is silty clay loam in the upper part, mottled silty clay loam in the next part, and mottled silty clay in the lower part. The upper part of the substratum is very dark gray, mottled silty clay. The lower part to a depth of about 60 inches is dark olive gray, mottled loam.

The poorly drained Vallers soils are on flats, generally surrounding depressions. They are moderately saline in most places. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 25 inches thick. It is dark gray in the upper part, light olive gray in the next part, and olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is dark gray, mottled loam.

Easby, Exline, Parnell, and Tonka are the minor soils in this association. The strongly saline Easby and alkali Exline soils are on flats. Easby soils are poorly drained and have accumulated lime in the subsoil. Exline soils are somewhat poorly drained. Parnell soils are in depressions. They have a silty clay loam surface layer and have accumulated clay in the subsoil. The poorly drained Tonka soils are in shallow depressions. They have a leached subsurface layer and have accumulated clay in the subsoil.

Most areas of this association are used as habitat for wetland wildlife or for hayland or pasture. Some areas are used for cultivated crops. Locating suitable drainage outlets is difficult. Most areas are best suited to wetland wildlife habitat, hayland, and pasture. Areas where water is ponded provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation. Some areas

are suited to small grain and sunflowers. The main concerns in managing cultivated crops are controlling soil blowing, reducing wetness, and overcoming salinity.

Most areas of this association are generally unsuited to buildings and septic tank absorption fields because of the ponding and slow permeability. Some of the higher areas are suited to buildings and septic tank absorption fields, but the wetness, the moderately slow permeability, the shrink-swell potential, and the salinity are limitations.

Level to Gently Sloping, Silty and Clayey Soils on Till Plains and Lake Plains

These soils formed in glaciolacustrine deposits and glacial till. They make up about 5 percent of the county. In most areas runoff flows into streams through constructed drains and road ditches. A few depressions and drainageways are in most areas. The soils are well suited to cultivated crops, hay, pasture, and range.

6. Gardena-Glyndon-Overly Association

Deep, level to gently sloping, moderately well drained and somewhat poorly drained, medium textured and moderately fine textured soils

This association is on flats and rises and in swales on lake plains. The landscape is dotted with knolls and shallow depressions. Runoff flows into depressions and shallow drainageways. Slope ranges from 0 to 6 percent.

This association makes up about 4 percent of the county. It is about 30 percent Gardena soils, 14 percent Glyndon soils, 14 percent Overly soils, and 42 percent soils of minor extent.

The level to gently sloping, moderately well drained Gardena soils are on rises. Typically, the surface layer is silt loam about 24 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is silt loam about 20 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, stratified silt loam and very fine sandy loam.

The level and nearly level, somewhat poorly drained Glyndon soils are on flats and in swales. Typically, the surface layer is black silt loam about 8 inches thick. The next layer is very dark brown silt loam about 3 inches thick. The subsoil is silt loam about 17 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The upper part of the substratum is light yellowish brown silt loam. The next part is light olive brown, mottled silt loam. The lower part to a depth of about 60 inches is light olive brown, mottled very fine sandy loam.

The level, moderately well drained Overly soils are on rises. Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil is silty clay loam about 29 inches thick. In sequence downward, it is black, dark grayish brown, grayish brown and mottled, and light olive brown and mottled. The upper part of the substratum is light olive brown, mottled silty clay loam. The lower part to a depth of about 60 inches is light brownish gray, mottled very fine sandy loam.

Bearden, Colvin, Egeland, and Zell are the minor soils in this association. The somewhat poorly drained Bearden soils are on flats. The poorly drained Colvin soils are in swales. Bearden and Colvin soils have a silty clay loam subsoil. The well drained Egeland soils are on rises. They have a fine sandy loam surface layer and subsoil. The well drained Zell soils are on rises and side slopes. They are calcareous throughout and do not have mottles.

Most areas of this association are used for cultivated crops. The soils are well suited to small grain, soybeans, sunflowers, range, and pasture. The main concern in managing cultivated crops is controlling water erosion and soil blowing.

The main limitations on sites for septic tank absorption fields are the wetness and moderately slow and moderate permeability. The main limitation on sites for buildings with basements is the wetness.

7. Kranzburg-Lismore-Fargo Association

Deep, level to undulating, well drained, moderately well drained, and poorly drained, moderately fine textured and fine textured soils

This association is on rises and flats and in swales on till plains and lake plains. The landscape is dotted with low knolls, ridges, and shallow depressions. Runoff flows into depressions and drainageways. Slope ranges from 0 to 6 percent.

This association makes up about 1 percent of the county. It is about 28 percent Kranzburg soils, 26 percent Lismore soils, 18 percent Fargo soils, and 28 percent soils of minor extent.

The level to undulating, well drained Kranzburg soils are on rises. Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil is about 26 inches thick. In sequence downward, it is very dark grayish brown silty clay loam, dark grayish brown silty clay loam, brown clay loam, and light olive brown loam.

The substratum to a depth of about 60 inches is light olive brown loam. It is mottled at a depth of 43 to 60 inches.

The level to undulating, moderately well drained Lismore soils are in swales. Typically, the surface soil is black silty clay loam about 11 inches thick. The subsoil is about 29 inches thick. It is very dark grayish brown silty clay loam in the upper part; dark grayish brown clay loam in the next part; and light olive brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam.

The level, poorly drained Fargo soils are on flats. Typically, the surface layer is black silty clay about 8 inches thick. The subsoil is silty clay about 29 inches thick. It is very dark brown in the upper part and dark grayish brown in the lower part. It is mottled at a depth of about 30 to 37 inches. The substratum to a depth of about 60 inches is olive gray and mottled. It is silty clay in the upper part and clay in the lower part.

Buse, Dovray, Hamerly, and Tonka are the minor soils in this association. The well drained Buse soils are on ridges and knolls. They have a calcareous surface layer, subsoil, and substratum. The very poorly drained Dovray soils are in depressions. The somewhat poorly drained Hamerly soils are on flats. They have accumulated lime in the subsoil. Tonka soils are in shallow depressions. They have a leached subsurface layer and have accumulated clay in the subsoil.

Most areas of this association are used for cultivated crops. The soils are well suited to small grain, sunflowers, range, and pasture. The main concerns in managing cultivated crops are controlling soil blowing and water erosion, maintaining tilth, and reducing wetness in the Fargo soils.

The main limitations on sites for septic tank absorption fields are the wetness and slow or moderately slow permeability. The main limitations on building sites are the wetness and the shrink-swell potential.

Level to Moderately Steep, Loamy Soils on Outwash Plains and Terraces

These soils formed in glaciofluvial deposits. They make up about 4 percent of the county. Runoff flows into streams and drainageways. The soils are suited to cultivated crops, hay, pasture, and range.

8. Renshaw-Divide-Fordville Association

Deep, level to moderately steep, somewhat excessively drained, somewhat poorly drained, and well drained, medium textured soils

This association is on flats and in swales on outwash plains and terraces. Most areas are dotted with depressions, knolls, and ridges. Slope ranges from 0 to 25 percent.

This association makes up about 4 percent of the county. It is 36 percent Renshaw soils, 23 percent Divide soils, 16 percent Fordville soils, and 25 percent soils of minor extent.

The level to moderately steep, somewhat excessively drained Renshaw soils are on flats. Typically, the surface layer is black loam about 8 inches thick. The subsoil is very dark grayish brown loam about 8 inches thick. The substratum to a depth of about 60 inches is gravelly coarse sand. It is dark brown in the upper part and grayish brown in the lower part.

The level, somewhat poorly drained Divide soils are on flats and in swales. Typically, the surface soil is black loam about 11 inches thick. The subsoil is loam about 17 inches thick. It is dark grayish brown in the upper part and grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown gravelly coarse sand.

The level and nearly level, well drained Fordville soils are on flats. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 26 inches thick. It is very dark grayish brown in the upper part and light brownish gray in the lower part. The substratum extends to a depth of about 60 inches. It is dark grayish brown sand in the upper part, dark brown very gravelly sand in the next part, and very dark grayish brown very gravelly sand in the lower part.

Barnes, Colvin, Marysland, and Sioux are the minor soils in this association. The well drained Barnes soils are on low knolls. They have a loam substratum. The poorly drained Colvin soils are on flats and in shallow depressions. They have accumulated lime in the subsoil. The poorly drained Marysland soils are on flats and in swales. The excessively drained Sioux soils are on knolls and ridges. They have a very gravelly sand substratum at a depth of less than 10 inches.

Most areas of this association are used for cultivated crops; however, some areas are used for hay or pasture. These soils are suited to small grain, pasture, and hay. The Sioux soils are best suited to hay, pasture, and range. The main concerns in managing cultivated crops are controlling soil blowing and overcoming droughtiness. The main concern in managing hay, range, or pasture is maintaining an

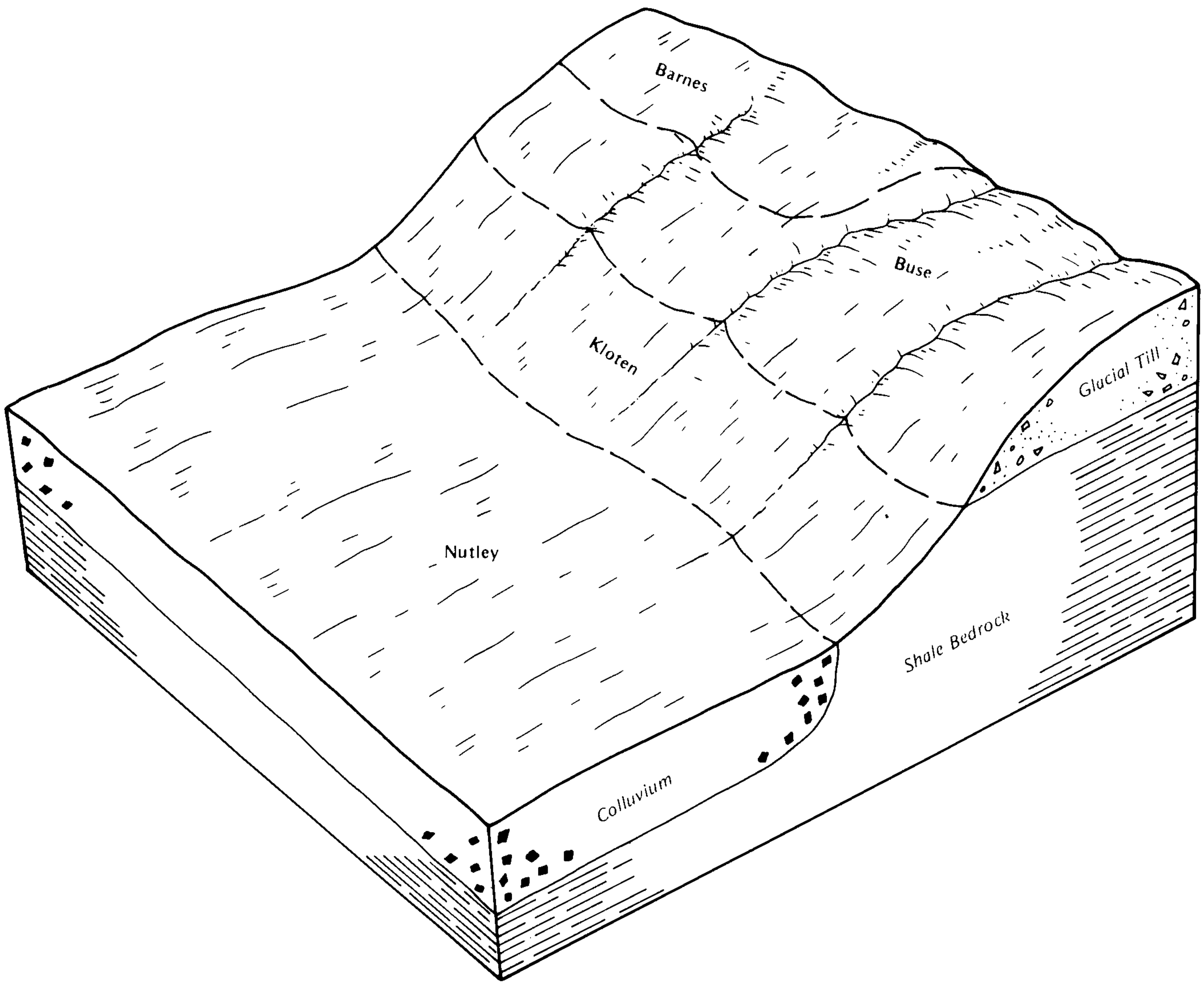

Figure 3.—Typical pattern of soils and parent material in the Buse-Barnes-Nutley-Kloten association.

adequate cover of the suitable hay and pasture plants or the important forage plants.

The main limitation on sites for septic tank absorption fields is rapid permeability, which can result in the pollution of ground water. The soils are well suited to use as building sites; however, the slope is a limitation on the strongly sloping and moderately steep soils.

Level to Steep, Loamy, Silty, and Clayey Soils in Stream Valleys

These soils formed in glacial till, colluvium, and material weathered from shale bedrock. They make up about 9 percent of the county. Runoff flows into streams. The Nutley soils are well suited to cultivated crops, pasture, and hay. All of the soils are suited to range.

9. Buse-Barnes-Nutley-Kloten Association

Shallow and deep, level to steep, well drained, fine textured, medium textured, and moderately fine textured soils

This association is on summits, shoulder slopes, side slopes, and foot slopes in stream valleys. Runoff flows into streams. Slope ranges from 0 to 35 percent.

This association makes up about 9 percent of the

county. It is about 19 percent Buse soils, 14 percent Barnes soils, 10 percent Nutley soils, 8 percent Kloten soils, and 49 percent soils of minor extent (fig. 3).

The strongly sloping to steep, deep Buse soils are on summits and shoulder slopes. Typically, the surface layer is black loam about 6 inches thick. The subsoil is loam about 15 inches thick. The upper part is dark grayish brown, and the lower part is grayish brown. The next layer is grayish brown, mottled loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled loam.

The gently sloping to hilly, deep Barnes soils are on side slopes and summits. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 22 inches thick. In sequence downward, it is very dark grayish brown, dark brown, dark grayish brown, and grayish brown. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

The level to strongly sloping, deep Nutley soils are on foot slopes. Typically, the surface layer is very dark grayish brown silty clay about 8 inches thick. The subsoil is about 28 inches thick. It is very dark grayish brown silty clay in the upper part, dark grayish brown silty clay in the next part, and dark grayish brown clay in the lower part. The upper part of the substratum is grayish brown clay. The lower part to a depth of about 60 inches is olive gray, mottled clay.

The strongly sloping to steep, shallow Kloten soils are on side slopes. Typically, the surface layer is very dark grayish brown silty clay loam about 5 inches thick. The next layer is dark grayish brown silty clay loam about 5 inches thick. The substratum to a depth of about 16 inches is dark gray very channery silty clay loam. Below this is shale bedrock.

Hamerly, LaDelle, Svea, and Vallers are the minor soils in this association. The somewhat poorly drained Hamerly soils are on flats. They have accumulated lime in the subsoil. The moderately well drained LaDelle soils are on flood plains. They have a silty clay loam subsoil and substratum. The moderately well drained Svea soils are in swales. They have a loam surface layer and subsoil. Vallers soils are poorly drained and are on flats.

Most areas of this association are used for cultivated crops; however, the moderately steep and steep soils are used mostly for range. Native woodland is common in some areas of the flood plains and on some of the steeper soils. The moderately steep and steep soils exhibit evidence of soil slippage, such as slump scars and slump mounds. The level to strongly sloping soils are suited to small grain and sunflowers. The moderately steep and steep soils are best suited to range. The main concerns in managing cultivated crops are controlling water erosion and soil blowing and maintaining or improving tilth. The main concerns in managing range are maintaining an adequate cover of the important forage plants and achieving a uniform distribution of grazing.

The main limitations on sites for septic tank absorption fields are the slope, the depth to bedrock, and slow permeability. The main limitations on building sites are the shrink-swell potential, the depth to bedrock, and the slope.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Nutley silty clay, 2 to 6 percent slopes, is a phase of the Nutley series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Hamerly-Tonka complex, 0 to 3 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Manfred and Vallers soils, extremely stony, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Some of the boundaries and soil names on the detailed soil maps of Barnes County do not match those on the detailed soil maps of Cass and Lamoure Counties. The differences are a result of improvements in the classification of soils, particularly in modification or refinements in soil series concepts. Also, there may be differences in the intensity of mapping or in the extent of soils within the survey area.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

2—Tonka silt loam. This deep, level, poorly drained soil is in shallow depressions on till plains. It is subject to ponding. Individual areas range from 3 to 20 acres in size.

Typically, the surface soil is black silt loam about 13 inches thick. The subsurface layer is dark grayish brown, mottled silt loam about 5 inches thick. The subsoil is about 21 inches thick. It is dark grayish brown clay loam in the upper part; olive gray, mottled clay in the next part; and dark grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is olive gray silt loam. In places the soil does not have a subsurface layer.

Included with this soil in mapping are small areas of Hamerly, Parnell, and Vallers soils. These soils make up about 20 percent of the unit. The somewhat poorly drained Hamerly and poorly drained Vallers soils generally surround the depressions. They are highly calcareous. The very poorly drained Parnell soils are in the deepest part of the depressions. They have a silty clay loam surface layer.

Permeability is slow in the Tonka soil, and runoff is ponded. A seasonal high water table is 6 inches above the surface to 1 foot below. Available water capacity is high. Organic matter content also is high. Tilth is good.

Most areas are used for cultivated crops, but some are used for hay, range, or wetland wildlife habitat. If drained, this soil is suited to small grain, flax, and sunflowers. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. In undrained areas, ponding usually delays tillage, seeding, or harvesting and crops are harvested in only about 5 to 7 years out of 10. The hazards of soil blowing and water erosion are slight. They are easily controlled by a system of conservation tillage that leaves crop residue on the surface. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife. This soil and the ponded water provide breeding areas and habitat for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The important range plants on this soil are slim sedge, wooly sedge, and prairie cordgrass. Creeping foxtail, reed canarygrass, and smooth bromegrass are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred when the soil is wet.

Drained areas of this soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover can improve the survival and growth rates of the seedlings.

This soil generally is unsuited to buildings and septic tank absorption fields because of the ponding and the slow permeability. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 41 to 83, depending on the degree of drainage. The range site is Wet Meadow.

3—Parnell silty clay loam. This deep, level, very poorly drained soil is in deep depressions on till plains. It is subject to ponding. Individual areas range from 3 to 40 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil is silty clay about 27 inches thick. It is black in the upper part and very dark gray in the lower part. The substratum extends to a depth of about 60 inches. It is olive gray, mottled silty clay in the upper part and gray, mottled clay loam in the lower part.

Included with this soil in mapping are small areas of Easby, Tonka, and Vallers soils. These soils make up about 25 percent of the unit. The poorly drained Easby and Vallers soils generally surround the depressions. They are highly calcareous. The poorly drained Tonka soils are in the shallower part of the depressions. They have a leached subsurface layer.

Permeability is slow in the Parnell soil, and runoff is ponded. A seasonal high water table is 2 feet above the surface to 2 feet below. Available water capacity and organic matter content are high. Tilth is fair.

Most areas are used for hay, range, or wetland wildlife habitat. If drained, this soil is suited to small grain, flax, and sunflowers. Locating suitable drainage outlets is difficult. As a result, few areas are drained. In undrained areas, ponding usually prevents tillage, seeding, or harvesting and crops are harvested in only about 1 or 2 years out of 10. This soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The important range plants on this soil are slough sedge and rivergrass. Where the soil is drained, reed

canarygrass and creeping foxtail are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred while the soil is wet.

Drained areas of this soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover can improve the survival and growth rates of the seedlings.

This soil generally is unsuited to buildings and septic tank absorption fields because of the ponding and the slow permeability. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 25 to 75, depending on the degree of drainage. The range site is Wetland.

6—Southam silty clay loam. This deep, level, very poorly drained soil is in deep depressions on till plains. It is subject to ponding. Individual areas range from 5 to 50 acres in size.

Typically, the surface soil is black and is about 29 inches thick. It has a 2-inch cover of organic material. It is silty clay loam in the upper part, mottled silty clay loam in the next part, and mottled silty clay in the lower part. The substratum extends to a depth of about 60 inches. It is mottled. It is very dark gray silty clay in the upper part and dark olive gray loam in the lower part. In places the surface is continuously ponded.

Included with this soil in mapping are small areas of Colvin, Easby, and Vallers soils. Also included are a few areas of noncalcareous soils. Included soils make up about 15 percent of the unit. Colvin, Easby, and Vallers soils have a layer of accumulated lime within a depth of 16 inches. They generally surround the depressions.

Permeability is slow in the Southam soil, and runoff is ponded. A seasonal high water table is 5 feet above the surface to 1 foot below. Available water capacity is high. Organic matter content is very high.

Most areas are used for wetland wildlife habitat. This soil is best suited to this use. It generally is unsuited to cultivated crops, hay, pasture, and trees and shrubs because of the ponding. Locating suitable drainage outlets is difficult. As a result, few areas are drained. The soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

This soil generally is unsuited to buildings and septic tank absorption fields because of the ponding and the slow permeability. Better sites generally are nearby.

The land capability classification is VIIIw. The productivity index for spring wheat is 0. A range site is not assigned.

9—Nutley silty clay, 0 to 2 percent slopes. This deep, level and nearly level, well drained soil is on foot slopes in stream valleys. Individual areas range from 10 to 100 acres in size.

Typically, the surface layer is very dark grayish brown silty clay about 8 inches thick. The subsoil is about 28 inches thick. It is very dark grayish brown silty clay in the upper part, dark grayish brown silty clay in the next part, and dark grayish brown clay in the lower part. The substratum to a depth of about 60 inches is clay. It is dark grayish brown in the upper part and olive gray and mottled in the lower part. In some places the surface layer is silty clay loam. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with this soil in mapping are small areas of the poorly drained Fargo soils in swales. These soils make up about 5 percent of the unit.

Permeability is slow in the Nutley soil. Runoff also is slow. Available water capacity and organic matter content are high. Tilth is poor.

Most areas are used for cultivated crops. This soil is suited to small grain, corn, sunflowers, soybeans, and alfalfa (fig. 4). The main concerns in managing cultivated areas are controlling soil blowing and water erosion and maintaining or improving tilth. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, windbreaks, buffer strips, diversions, and grassed waterways in areas where runoff concentrates help to control soil blowing and water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Tillage when the soil is neither too wet nor too dry helps to prevent surface compaction and improves tilth. Fall plowing leaves the soil in good condition for seedbed preparation in the spring, but it increases the hazard of soil blowing.

The important range plants on this soil are western wheatgrass and green needlegrass. Altai wildrye,

Figure 4.—Alfalfa hay in an area of Nutley silty clay, 0 to 2 percent slopes.

intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The slow permeability is a limitation on sites for septic tank

absorption fields, but it can be overcome by enlarging the field.

The land capability classification is IIs. The productivity index for spring wheat is 85. The range site is Clayey.

9B—Nutley silty clay, 2 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on foot slopes in stream valleys. Individual areas range from 15 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silty clay about 8 inches thick. The subsoil is about 28 inches thick. It is very dark grayish brown silty clay in the upper part, dark grayish brown silty clay in the next part, and dark grayish brown clay in the lower part. The substratum to a depth of about 60 inches is clay. It is grayish brown in the upper part and olive gray and mottled in the lower part. In some places the surface layer is silty clay loam. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with this soil in mapping are small areas of the poorly drained Fargo soils in swales. Also included are some areas of soils that have shale bedrock at a depth of 40 to 60 inches. Included soils make up about 5 percent of the unit.

Permeability is slow in the Nutley soil, and runoff is medium. Available water capacity and organic matter content are high. Tilth is poor.

Most areas are used for cultivated crops. This soil is suited to small grain, corn, sunflowers, and soybeans. The main concerns in managing cultivated areas are controlling water erosion and soil blowing and maintaining or improving tilth. The hazards of soil blowing and water erosion are moderate. A system of conservation tillage, field windbreaks, buffer strips, diversions, terraces, and grassed waterways in areas where runoff concentrates help to control soil blowing and water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Tillage when the soil is neither too wet nor too dry helps to prevent surface compaction and improves tilth. Fall plowing leaves the soil in good condition for seedbed preparation in the spring, but it increases the hazard of soil blowing.

The important range plants on this soil are western wheatgrass and green needlegrass. Altai wildrye, intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing and water erosion.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The slow permeability is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification is IIe. The productivity index for spring wheat is 75. The range site is Clayey.

9D—Nutley silty clay, 6 to 15 percent slopes. This deep, moderately sloping and strongly sloping, well drained soil is on foot slopes in stream valleys. Individual areas range from 15 to 200 acres in size.

Typically, the surface layer is black silty clay about 8 inches thick. The subsoil is about 28 inches thick. It is very dark grayish brown silty clay in the upper part, dark grayish brown silty clay in the next part, and dark grayish brown clay in the lower part. The substratum to a depth of about 60 inches is clay. It is grayish brown in the upper part and olive gray and mottled in the lower part. In some places the surface layer is silty clay loam. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with this soil in mapping are small areas of the well drained Kloten and Buse soils on side slopes. Also included, on side slopes, are small areas of soils that have shale bedrock at a depth of 40 to 60 inches. Included soils make up about 15 percent of the unit. Kloten soils are shallow to shale bedrock. Buse soils have a loam surface layer and subsoil.

Permeability is slow in the Nutley soil, and runoff is rapid. Available water capacity and organic matter content are high. Tilth is poor.

Most areas are used for cultivated crops. This soil is suited to small grain. It is well suited to range, hay, and pasture. The main concerns in managing cultivated areas are controlling water erosion and soil blowing and maintaining or improving tilth. The hazard of soil

blowing is moderate, and the hazard of water erosion is severe. A system of conservation tillage, diversions, terraces, and grassed waterways in areas where runoff concentrates help to control soil blowing and water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Tillage when the soil is neither too wet nor too dry helps to prevent surface compaction and improves tilth. Fall plowing leaves the soil in good condition for seedbed preparation in the spring, but it increases the hazard of soil blowing.

The important range plants on this soil are western wheatgrass and green needlegrass. Altai wildrye, intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to control gullying.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The slow permeability is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field. The slope is a limitation on sites for buildings and absorption fields. The buildings and absorption fields can be designed so that they conform to the natural slope of the land.

The land capability classification is IVe. The productivity index for spring wheat is 52. The range site is Clayey.

12—Lismore-Kranzburg silty clay loams, 0 to 2 percent slopes. These deep, level and nearly level soils are on mantled till plains. The moderately well drained Lismore soil is in swales. The well drained Kranzburg soil is on rises. Individual areas range from 15 to 300 acres in size. They are 55 to 65 percent Lismore silty clay loam and 25 to 35 percent Kranzburg silty clay loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Lismore soil has a black silty clay loam surface soil about 11 inches thick. The subsoil is about 29 inches thick. It is very dark grayish brown silty clay loam in the upper part; dark grayish brown clay loam in the next part; and light olive brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam. In places the surface soil and subsoil are loam.

Typically, the Kranzburg soil has a black silty clay loam surface layer about 8 inches thick. The subsoil is about 26 inches thick. In sequence downward, it is very dark grayish brown silty clay loam, dark grayish brown silty clay loam, brown silty clay loam, and light olive brown loam. The substratum to a depth of about 60 inches is light olive brown loam. It is mottled at a depth of 43 to 60 inches. In some places the surface layer is eroded and is very dark grayish brown. In other places the upper part of the subsoil is silty clay. In some areas the surface soil is gravelly.

Included with these soils in mapping are small areas of Hamerly and Tonka soils. These included soils make up about 10 percent of the unit. The somewhat poorly drained Hamerly soils are on flats. They are highly calcareous. The poorly drained Tonka soils are in depressions. They have a leached subsurface layer.

Permeability is moderately slow in the Lismore and Kranzburg soils. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet in the Lismore soil. Organic matter content is high in both soils. Tilth is fair.

Most areas are used for cultivated crops. These soils are well suited to small grain, corn, and sunflowers. The main concern in managing cultivated areas is maintaining tilth and fertility. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion in areas where runoff concentrates. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Incorporating organic material into the surface layer improves or helps to maintain fertility and tilth.

The important range plants on these soils are big bluestem, porcupinegrass, and green needlegrass. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. No major hazards or limitations affect the use of these soils for range or pasture.

The Lismore soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Kranzburg soil is suited to nearly all adapted species. No critical limitations affect the use of these soils for trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements in areas of the Lismore soil. The moderately slow permeability of the Kranzburg soil is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table is a limitation if the Lismore soil is used as a site for septic tank absorption fields. A mound system helps to overcome this limitation.

The land capability classification of both soils is IIc. The productivity index of the unit for spring wheat is 94. The range site of the Lismore soil is Overflow, and that of the Kranzburg soil is Silty.

13B—Kranzburg-Lismore silty clay loams, 2 to 6 percent slopes. These deep, nearly level and undulating soils are on till plains. The well drained Kranzburg soil is on rises. The moderately well drained Lismore soil is in swales. Individual areas range from 5 to 120 acres in size. They are 55 to 70 percent Kranzburg silty clay loam and 15 to 30 percent Lismore silty clay loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Kranzburg soil has a black silty clay loam surface layer about 8 inches thick. The subsoil is about 26 inches thick. In sequence downward, it is very dark grayish brown silty clay loam, dark grayish brown silty clay loam, brown clay loam, and light olive brown loam. The substratum to a depth of about 60 inches is light olive brown loam. It is mottled at a depth of 43 to 60 inches. In some places the surface layer is eroded and is very dark grayish brown. In other places the upper part of the subsoil is silty clay. In some areas the surface layer and the upper part of the subsoil are loam. In a few areas the surface layer is gravelly.

Typically, the Lismore soil has a black silty clay loam surface soil about 11 inches thick. The subsoil is about 29 inches thick. It is very dark grayish brown silty clay loam in the upper part; dark grayish brown clay loam in the next part; and light olive brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam. In places the surface soil and subsoil are loam.

Included with these soils in mapping are small areas of Buse, Hamerly, and Tonka soils. These included soils make up about 15 percent of the unit. The well drained Buse soils are on knobs and ridges. They have a calcareous loam surface layer and subsoil. The somewhat poorly drained Hamerly soils are on flats. They are highly calcareous. The poorly drained Tonka soils are in depressions. They have a leached subsurface layer.

Permeability is moderately slow in the Kranzburg and Lismore soils. Runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet in the Lismore soil. Organic matter content is high in both soils. Tilth is fair.

Most areas are used for cultivated crops. These soils are well suited to small grain, corn, and sunflowers. The main concerns in managing cultivated areas are controlling water erosion and maintaining or improving tilth. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. A system of conservation tillage that leaves crop residue on the surface and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Incorporating organic material into the surface layer improves or helps to maintain tilth.

The important range plants on these soils are big bluestem, porcupinegrass, and green needlegrass. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control water erosion.

The Kranzburg soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Lismore soil is suited to all adapted species. No critical limitations affect the use of these soils for trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and

foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements in areas of the Lismore soil. The moderately slow permeability of the Kranzburg soil is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table is a limitation if the Lismore soil is used as a site for septic tank absorption fields. A mound system helps to overcome this limitation.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 79. The range site of both soils is Silty.

14B—Barnes-Buse loams, 3 to 6 percent slopes. These deep, undulating, well drained soils are on till plains. The Barnes soil is on side slopes. The Buse soil is on knolls, shoulder slopes, and ridges. Individual areas range from 15 to 160 acres in size. They are 50 to 55 percent Barnes loam and 30 to 35 percent Buse loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 22 inches thick. In sequence downward, it is very dark grayish brown, dark brown, dark grayish brown, and grayish brown. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the surface layer is eroded and is very dark grayish brown.

Typically, the Buse soil has a black loam surface layer about 6 inches thick. The subsoil is loam about 15 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The next layer is grayish brown, mottled loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled loam. In places the surface layer is eroded and is dark grayish brown.

Included with these soils in mapping are small areas of Hamerly, Svea, and Tonka soils. Also included are small areas of sand and gravel on knolls and knobs. Included areas make up about 20 percent of the unit. The somewhat poorly drained Hamerly soils are on flats. They are highly calcareous. The moderately well drained Svea soils are in swales. They are dark to a depth of 16 inches or more. The poorly drained Tonka soils are in depressions. They have a leached subsurface layer.

Permeability is moderately slow in the Barnes and Buse soils. Runoff is medium. Available water capacity is high. Organic matter content is high in the Barnes soil and moderately low in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are well suited to small grain, corn, and sunflowers (fig. 5). The main concern in managing cultivated areas is controlling water erosion and soil blowing. The hazard of soil blowing is slight on the Barnes soil and moderate on the Buse soil. The hazard of water erosion is moderate on both soils. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help to control soil blowing and water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on these soils are western wheatgrass, green needlegrass, little bluestem, and porcupinegrass. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control water erosion and soil blowing.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited only to the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification of the Barnes soil is IIe, and that of the Buse soil is IIIe. The productivity index of the unit for spring wheat is 69. The range site of the Barnes soil is Silty, and that of the Buse soil is Thin Upland.

14C—Barnes-Buse loams, 6 to 9 percent slopes. These deep, gently rolling, well drained soils are on till plains. The Barnes soil is on side slopes. The Buse soil

Figure 5.—Sunflowers in an area of Barnes-Buse loams, 3 to 6 percent slopes. The field windbreak helps to control soil blowing and minimizes abrasion of seedlings.

is on knolls and ridges. Individual areas range from 15 to 120 acres in size. They are 45 to 55 percent Barnes loam and 25 to 35 percent Buse loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 22 inches thick. In sequence downward, it is very dark grayish brown, dark brown, dark grayish brown, and grayish brown. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the surface layer is eroded and is very dark grayish brown.

Typically, the Buse soil has a black loam surface layer about 6 inches thick. The subsoil is loam about 15 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The next layer is grayish brown, mottled loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled loam. In places the surface layer is eroded and is dark grayish brown.

Included with these soils in mapping are small areas of Hamerly and Svea soils. These included soils make up about 20 percent of the unit. The somewhat poorly drained Hamerly soils are on flats. They are highly calcareous. The moderately well drained Svea soils are in swales. They are dark to a depth of 16 inches or more.

Permeability is moderately slow in the Barnes and Buse soils. Runoff is rapid. Available water capacity is high. Organic matter content is high in the Barnes soil and moderately low in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils

are suited to small grain. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The hazard of soil blowing is slight on the Barnes soil and moderate on the Buse soil. The hazard of water erosion is severe on both soils. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help to control soil blowing and water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on these soils are western wheatgrass, green needlegrass, little bluestem, and porcupinegrass. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited only to the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification of the Barnes soil is IIIe, and that of the Buse soil is IVe. The productivity index of the unit for spring wheat is 54. The range site of the Barnes soil is Silty, and that of the Buse soil is Thin Upland.

14D—Barnes-Buse loams, 9 to 15 percent slopes. These deep, rolling, well drained soils are on till plains. The Barnes soil is on side slopes. The Buse soil is on knolls and ridges. Individual areas range from 15 to 100 acres in size. They are about 55 to 70 percent Barnes loam and 30 to 40 percent Buse loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 22 inches thick. In sequence downward, it is very dark grayish brown, dark brown, dark grayish brown, and grayish brown. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the surface layer is eroded and is very dark grayish brown. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Buse soil has a black loam surface layer about 6 inches thick. The subsoil is loam about 15 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The next layer is grayish brown, mottled loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled loam. In some places the surface layer is eroded and is dark grayish brown. In other places the soil is silt loam or very fine sandy loam throughout.

Included with these soils in mapping are small areas of Sioux and Swenoda soils. These included soils make up about 5 percent of the unit. The excessively drained Sioux soils are on knolls, ridges, and knobs. They have a very gravelly sand substratum. The moderately well drained Swenoda soils are in swales. They are fine sandy loam in the surface layer and the upper part of the subsoil.

Permeability is moderately slow in the Barnes and Buse soils. Runoff is very rapid. Available water capacity is high. Organic matter content is high in the Barnes soil and moderately low in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are poorly suited to small grain. They are well suited to pasture, hay, and range. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The hazard of soil blowing is slight on the Barnes soil and moderate on the Buse soil. The hazard of water erosion is very severe on both soils. A system of conservation tillage that leaves crop residue on the surface, a crop rotation that includes grasses and legumes, windbreaks, and buffer strips help to control soil blowing and water erosion. These practices, however, may not adequately protect the soils. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on these soils are western wheatgrass, green needlegrass, little bluestem,

and porcupinegrass. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited only to the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field. The slope is a limitation on sites for buildings and septic tank absorption fields. The buildings and absorption fields can be designed so that they conform to the natural slope of the land.

The land capability classification of the Barnes soil is IVe, and that of the Buse soil is VIe. The productivity index of the unit for spring wheat is 37. The range site of the Barnes soil is Silty, and that of the Buse soil is Thin Upland.

15—Swenoda-Lanona fine sandy loams, 0 to 2 percent slopes. These deep, level and nearly level soils are on shorelines of lake plains. The moderately well drained Swenoda soil is in swales. The well drained Lanona soil is on rises. Individual areas range from 5 to 70 acres in size. They are 45 to 60 percent Swenoda fine sandy loam and 30 to 45 percent Lanona fine sandy loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Swenoda soil has a black fine sandy loam surface layer about 8 inches thick. The subsoil is about 34 inches thick. It is very dark grayish brown fine sandy loam in the upper part, dark grayish brown fine sandy loam in the next part, and dark grayish brown loam in the lower part. The next layer is grayish brown, mottled loam about 8 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Typically, the Lanona soil has a black fine sandy loam surface layer about 8 inches thick. The subsoil is about 34 inches thick. It is very dark grayish brown fine sandy loam in the upper part, dark grayish brown fine sandy loam in the next part, and grayish brown loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the substratum has a thin stratum of silt and pebbles.

Included with these soils in mapping are small areas of Barnes and Egeland soils. These included soils make up about 5 percent of the unit. The well drained Barnes soils have a loam surface layer and subsoil. They occur as areas intermingled with areas of the Lanona soil. The well drained Egeland soils are in swales. They have a fine sandy loam substratum.

Permeability is moderately rapid in the upper part of the Swenoda and Lanona soils and moderately slow in the lower part. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 2.5 to 4.0 feet in the Swenoda soil. Organic matter content is high in the Swenoda soil and moderate in the Lanona soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on these soils are prairie sandreed and needleandthread. Green needlegrass, intermediate wheatgrass, prairie sandreed, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

The Swenoda soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Lanona soil is suited to

many of the adapted species. Irrigation helps to ensure the survival of seedlings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings. The Lanona soil is suited to septic tank absorption fields, but the Swenoda soil is poorly suited. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements in areas of the Swenoda soil. The moderately slow permeability of the Lanona soil is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table is a limitation if the Swenoda soil is used as a site for septic tank absorption fields. A mound system helps to overcome this limitation.

The land capability classification of both soils is IIIe. The productivity index of the unit for spring wheat is 76. The range site of both soils is Sandy.

15B—Lanona-Swenoda fine sandy loams, 2 to 6 percent slopes. These deep, nearly level and gently sloping soils are on shorelines of lake plains. The well drained Lanona soil is on rises and low knolls. The moderately well drained Swenoda soil is in swales. Individual areas range from 5 to 70 acres in size. They are 60 to 70 percent Lanona fine sandy loam and 25 to 35 percent Swenoda fine sandy loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Lanona soil has a black fine sandy loam surface layer about 8 inches thick. The subsoil is about 34 inches thick. It is very dark grayish brown fine sandy loam in the upper part, dark grayish brown fine sandy loam in the next part, and grayish brown loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the substratum has a thin stratum of silt and pebbles.

Typically, the Swenoda soil has a black fine sandy loam surface layer about 8 inches thick. The subsoil is about 34 inches thick. It is very dark grayish brown fine sandy loam in the upper part, dark grayish brown fine sandy loam in the next part, and dark grayish brown loam in the lower part. The next layer is grayish brown, mottled loam about 8 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Included with these soils in mapping are small areas of Barnes, Buse, Egeland, and Sioux soils. These included soils make up about 10 percent of the unit. The well drained Barnes and Buse soils have a loam surface layer and subsoil. Barnes soils occur as areas intermingled with areas of the Lanona soil. Buse soils are on knobs. The well drained Egeland soils have a fine sandy loam substratum. They occur as areas intermingled with areas of the Lanona soil. The excessively drained Sioux soils are on the lower ridges. They have a gravelly substratum.

Permeability is moderately rapid in the upper part of the Lanona and Swenoda soils and moderately slow in the lower part. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 2.5 to 4.0 feet in the Swenoda soil. Organic matter content is moderate in the Lanona soil and high in the Swenoda soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on these soils are prairie sandreed and needleandthread. Green needlegrass, intermediate wheatgrass, prairie sandreed, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

The Lanona soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Swenoda soil is suited to all of the adapted species. Irrigation helps to ensure the survival of seedlings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect

the seedlings from abrasion.

These soils are suited to buildings. The Lanona soil is suited to septic tank absorption fields, but the Swenoda soil is poorly suited. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements in areas of the Swenoda soil. The moderately slow permeability of the Lanona soil is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table is a limitation if the Swenoda soil is used as a site for septic tank absorption fields. A mound system helps to overcome this limitation.

The land capability classification of both soils is IIIe. The productivity index of the unit for spring wheat is 62. The range site of both soils is Sandy.

15C—Lanona fine sandy loam, 6 to 9 percent slopes. This deep, gently rolling, well drained soil is on rises on lake plains. Individual areas range from 15 to 80 acres in size.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsoil is about 34 inches thick. It is very dark grayish brown fine sandy loam in the upper part, dark grayish brown fine sandy loam in the next part, and grayish brown loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the substratum has a thin stratum of silt and pebbles. In other places it is fine sandy loam.

Included with this soil in mapping are small areas of Sioux, Swenoda, and Zell soils. These soils make up about 30 percent of the unit. The excessively drained Sioux soils are on ridges. They have a gravelly substratum. The well drained Swenoda soils are in swales. They are dark to a depth of more than 16 inches. The well drained Zell soils are on knolls and ridges. They have a very fine sandy loam substratum.

Permeability is moderately rapid in the upper part of the Lanona soil and moderately slow in the lower part. Runoff is medium. Available water capacity is high, and organic matter content is moderate. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain, corn, and sunflowers. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The hazard of soil blowing is severe, and the hazard of water erosion is moderate. A system of conservation tillage that leaves crop residue on the surface, windbreaks, buffer strips, and grassed waterways in areas where runoff concentrates help to control soil blowing and water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on this soil are prairie sandreed and needleandthread. Prairie sandreed, sand bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants at a height that traps snow helps to store water in the soil and to control soil blowing. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Irrigation helps to ensure the survival of seedlings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on sites for buildings with basements. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification is IVe. The productivity index for spring wheat is 47. The range site is Sandy.

16B—Barnes-Sioux loams, 1 to 6 percent slopes. These deep soils are on till plains, moraines, eskers, and kames. The well drained, nearly level Barnes soil is on side slopes. The excessively drained, gently sloping Sioux soil is on knobs and ridges (fig. 6). Individual areas range from 10 to 60 acres in size. They are 55 to 65 percent Barnes loam and 25 to 35 percent Sioux loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 22 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The

Figure 6.—An area of Barnes-Sioux loams, 1 to 6 percent slopes, prepared for seeding. The Barnes soil is in the dark areas, and the Sioux soil is in the light colored areas.

substratum to a depth of about 60 inches is light olive brown loam. In some places the surface layer is eroded and is very dark grayish brown. In other places the dark color of the surface layer extends to a depth of more than 16 inches. In some areas the soil has less clay and more sand throughout.

Typically, the Sioux soil has a black loam surface layer about 6 inches thick. The next layer is very dark gray gravelly loam about 2 inches thick. The upper part of the substratum is dark brown very gravelly coarse sand. The lower part to a depth of about 60 inches is dark brown, grayish brown, and gray extremely gravelly coarse sand.

Included with these soils in mapping are small areas of Buse and Renshaw soils. These included soils make up about 10 percent of the unit. The well drained Buse soils have a loam substratum. They occur as areas intermingled with areas of the Sioux soil. The somewhat excessively drained Renshaw soils are on side slopes. They have a gravelly coarse sand substratum at a depth of about 16 inches.

Permeability is moderately slow in the Barnes soil and rapid in the Sioux soil. Runoff is medium on the Barnes soil and slow on the Sioux soil. Available water capacity is high in the Barnes soil and low in the Sioux soil. Organic matter content is high in the Barnes soil and moderate in the Sioux soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain, corn, and sunflowers. The main concerns in managing cultivated areas are controlling water erosion on both soils and overcoming the droughtiness of the Sioux soil. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Because of the low available water capacity, overcoming the droughtiness of the Sioux soil is difficult.

The important range plants on these soils are western wheatgrass, needleandthread, green

needlegrass, and blue grama. Smooth bromegrass, western wheatgrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for range or pasture.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings, but the Sioux soil generally is unsuited. Trees and shrubs can be grown on the Sioux soil for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings.

These soils are suited to buildings. The Barnes soil is suited to septic tank absorption fields, but the Sioux soil is poorly suited. The shrink-swell potential of the Barnes soil is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability of the Barnes soil is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field. Because of the rapid permeability, the Sioux soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. If shallow excavations, such as those for basements, are dug in areas of the Sioux soil, the sides tend to cave in unless they are shored.

The land capability classification of the Barnes soil is IIe, and that of the Sioux soil is VIs. The productivity index of the unit for spring wheat is 59. The range site of the Barnes soil is Silty, and that of the Sioux soil is Very Shallow.

16C—Barnes-Sioux loams, 6 to 9 percent slopes. These deep, moderately sloping soils are on till plains, eskers, and kames. The well drained Barnes soil is on side slopes. The excessively drained Sioux soil is on knobs and ridges. Individual areas range from 5 to 40 acres in size. They are 50 to 60 percent Barnes loam and 25 to 35 percent Sioux loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 22 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In some places the surface layer is eroded and is very dark grayish brown. In other places the soil contains less clay and more sand. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Sioux soil has a black loam surface layer about 6 inches thick. The next layer is very dark gray gravelly loam about 2 inches thick. The upper part of the substratum is dark brown very gravelly coarse sand. The lower part to a depth of about 60 inches is dark brown, grayish brown, and gray extremely gravelly coarse sand.

Included with these soils in mapping are small areas of Buse, Hamerly, and Renshaw soils. These included soils make up about 15 percent of the unit. The well drained Buse soils have a loam substratum. They occur as areas intermingled with areas of the Sioux soil. The somewhat poorly drained Hamerly soils are on flats. They are highly calcareous. The somewhat excessively drained Renshaw soils are on side slopes. They have a gravelly coarse sand substratum at a depth of about 16 inches.

Permeability is moderately slow in the Barnes soil and rapid in the Sioux soil. Runoff is rapid on the Barnes soil and medium on the Sioux soil. Available water capacity is high in the Barnes soil and low in the Sioux soil. Organic matter content is high in the Barnes soil and moderately low in the Sioux soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain, corn, and sunflowers. The main concerns in managing cultivated areas are controlling water erosion on both soils and overcoming the droughtiness of the Sioux soil. The hazard of water erosion is severe, and the hazard of soil blowing is slight. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Because of the low available water capacity, the droughtiness of the Sioux soil is difficult to overcome.

The important range plants on these soils are western wheatgrass, needleandthread, green needlegrass, and blue grama. Smooth bromegrass, western wheatgrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as

windbreaks and environmental plantings, but the Sioux soil generally is unsuited. Trees and shrubs can be grown on the Sioux soil for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings.

These soils are suited to buildings. The Barnes soil is suited to septic tank absorption fields, but the Sioux soil is poorly suited. The shrink-swell potential of the Barnes soil is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability of the Barnes soil is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field. Because of the rapid permeability, the Sioux soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. If shallow excavations, such as those for basements, are dug in areas of the Sioux soil, the sides tend to cave in unless they are shored.

The land capability classification of the Barnes soil is IIIe, and that of the Sioux soil is VIs. The productivity index of the unit for spring wheat is 42. The range site of the Barnes soil is Silty, and that of the Sioux soil is Very Shallow.

16E—Barnes-Sioux loams, 9 to 25 percent slopes. These deep soils are on till plains, eskers, and kames. The well drained, strongly sloping Barnes soil is on side slopes. The excessively drained, moderately steep Sioux soil is on knobs and ridges. Individual areas range from 10 to 50 acres in size. They are 45 to 55 percent Barnes loam and 25 to 35 percent Sioux loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 22 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In some places the surface layer is eroded and is very dark grayish brown. In other places the soil has more sand and less clay. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Sioux soil has a black loam surface layer about 6 inches thick. The next layer is very dark gray gravelly loam about 2 inches thick. The upper part of the substratum is dark brown very gravelly coarse sand. The lower part to a depth of about 60 inches is dark brown, grayish brown, and gray extremely gravelly coarse sand.

Included with these soils in mapping are small areas of Buse and Renshaw soils. These included soils make up about 20 percent of the unit. The well drained Buse soils have a loam substratum. They occur as areas intermingled with areas of the Sioux soil. The somewhat excessively drained Renshaw soils are on side slopes. They have a gravelly coarse sand substratum at a depth of about 16 inches.

Permeability is moderately slow in the Barnes soil and rapid in the Sioux soil. Runoff is rapid on the Barnes soil and medium on the Sioux soil. Available water capacity is high in the Barnes soil and low in the Sioux soil. Organic matter content is high in the Barnes soil and moderately low in the Sioux soil. Tilth is good in both soils.

Most areas are used for pasture, range, or wildlife habitat; however, some areas are used for cultivated crops. The soils are best suited to range and hay. They generally are unsuited to cultivated crops because of the droughtiness of the Sioux soil and the slope on both soils. The main concerns in managing cultivated areas are controlling water erosion and overcoming the droughtiness of the Sioux soil. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion. Conservation tillage, however, may not adequately protect the soils. Because of the very low available water capacity, the droughtiness of the Sioux soil is difficult to overcome.

The important range plants on these soils are western wheatgrass, needleandthread, blue grama, and green needlegrass. Smooth bromegrass, western wheatgrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings, but the Sioux soil is generally unsuited. Trees and shrubs can be grown on the Sioux soil for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. Eliminating grasses

and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings.

These soils are suited to buildings. The Barnes soil is suited to septic tank absorption fields, but the Sioux soil is poorly suited. The shrink-swell potential of the Barnes soil is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability of the Barnes soil is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field. Because of the rapid permeability, the Sioux soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The slope is a limitation on sites for buildings and absorption fields. The buildings and absorption fields can be designed so that they conform to the natural slope of the land. If shallow excavations, such as those for basements, are dug in areas of the Sioux soil, the sides tend to cave in unless they are shored.

The land capability classification of the Barnes soil is IVe, and that of the Sioux soil is VIs. The productivity index of the unit for spring wheat is 0. The range site of the Barnes soil is Silty, and that of the Sioux soil is Very Shallow.

17B—Barnes-Svea loams, 2 to 6 percent slopes. These deep, nearly level and gently sloping soils are on till plains. The well drained Barnes soil is on rises. The moderately well drained Svea soil is in swales. Individual areas range from 5 to 150 acres in size. They are 50 to 60 percent Barnes loam and 25 to 35 percent Svea loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 22 inches thick. In sequence downward, it is very dark grayish brown, dark brown, dark grayish brown, and grayish brown. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the surface layer is eroded and is very dark grayish brown. In a few places the surface layer is silt loam. In some areas the surface layer and the upper part of the subsoil are silty clay loam.

Typically, the Svea soil has a black loam surface soil about 12 inches thick. The subsoil is loam about 31 inches thick. In sequence downward, it is very dark brown, very dark grayish brown, grayish brown and mottled, and light brownish gray and mottled. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the soil has less clay and more sand throughout.

Included with these soils in mapping are small areas of Buse, Hamerly, and Tonka soils. Also included are small areas of soils that have a gravelly loam surface layer. Included soils make up about 15 percent of the unit. The well drained Buse soils are on knobs and ridges. They have a subsoil that is calcareous throughout. The somewhat poorly drained Hamerly soils are on flats. They are highly calcareous. The poorly drained Tonka soils are in depressions. They have a leached subsurface layer.

Permeability is moderately slow in the Barnes and Svea soils. Runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are well suited to small grain, corn, and sunflowers. The main concern in managing cultivated areas is controlling water erosion. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on these soils are western wheatgrass, needleandthread, and green needlegrass. Smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. No major hazards or limitations affect the use of these soils for range or pasture.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Svea soil is suited to all adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings.

These soils are suited to buildings. The Barnes soil is suited to septic tank absorption fields, but the Svea soil is poorly suited. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements in areas of the Svea soil. The moderately slow permeability of the Barnes soil is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging

the absorption field. The seasonal high water table is a limitation if the Svea soil is used as a site for septic tank absorption fields. A mound system helps to overcome this limitation.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 85. The range site of both soils is Silty.

18—Bearden silty clay loam. This deep, level, somewhat poorly drained soil is on flats on lake plains. Individual areas range from 20 to 200 acres in size.

Typically, the surface soil is black silty clay loam about 9 inches thick. The subsoil is silty clay loam about 23 inches thick. It is grayish brown in the upper part and light olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown and mottled. It is silt loam in the upper part, silty clay loam in the next part, and silt loam in the lower part. In some places the surface layer is silt loam or loam. In other places the subsoil and substratum are loam.

Included with this soil in mapping are small areas of Colvin, Glyndon, and Overly soils. Also included are some areas of poorly drained soils. Included soils make up about 15 percent of the unit. The poorly drained Colvin soils are in swales. They have a brownish gray and gray substratum. The somewhat poorly drained Glyndon soils have a silt loam subsoil. They occur as areas intermingled with areas of the Bearden soil. The moderately well drained Overly soils are on low ridges. They are dark to a depth of 16 inches or more. The poorly drained soils have accumulated clay in the subsoil. They are in depressions.

Permeability is moderately slow in the Bearden soil, and runoff is slow. A seasonal high water table is at a depth of 2 to 4 feet. Available water capacity and organic matter content are high. Tilth is fair.

Most areas are used for cultivated crops. This soil is well suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on this soil are little bluestem and big bluestem. Tall wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements. The moderately slow permeability and seasonal high water table are limitations on sites for absorption fields. A mound system helps to overcome these limitations.

The land capability classification is IIe. The productivity index for spring wheat is 93. The range site is Limy Subirrigated.

19—Colvin silty clay loam, saline. This deep, level, poorly drained, highly calcareous, moderately saline soil is on flats and in swales on glacial lake plains. It is subject to flooding. Individual areas range from about 3 to 60 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. It contains salt crystals. The next layer is dark gray silty clay loam about 6 inches thick. It also contains salt crystals. The subsoil is about 23 inches thick. It is dark gray silt loam in the upper part; grayish brown, mottled silt loam in the next part; and very dark grayish brown silty clay loam in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled, stratified silt loam and silty clay loam. In some places the surface layer is silt loam. In other places it does not contain salt crystals. In some areas the surface layer and subsoil contain more sand and less silt.

Included with this soil in mapping are small areas of the saline Bearden, Glyndon, and Marysland soils. Also included, in depressions, are areas of some other poorly drained soils that have a silty clay or clay subsoil. Included soils make up about 10 percent of the unit. The somewhat poorly drained Bearden and Glyndon soils are on rises. They are light olive brown in the lower part of the substratum. The poorly drained

Marysland soils are on flats. They are underlain by gravelly coarse sand at a depth of 34 to 60 inches.

Permeability is moderately slow in the Colvin soil, and runoff is very slow. A seasonal high water table is between the surface and a depth of 2 feet. Available water capacity is moderate. Organic matter content is high. Tilth is fair. Salts reduce the amount of water available to plants.

Most areas are used for cultivated crops, hay, or pasture. This soil is best suited to hay, pasture, range, and wildlife habitat. It is poorly suited to cultivated crops because of the wetness and the salinity. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. In undrained areas the wetness delays or prevents tillage and seeding in some years. Fallowing should be avoided because it can result in salt accumulation in the surface layer. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing. Incorporating organic material into the surface layer helps to maintain or improve tilth.

The important range plants on this soil are western wheatgrass, inland saltgrass, and Nuttall alkaligrass. Alkali sacaton and sweetclover are suitable hay and pasture plants. The high salt content and the limited amount of available water in the soil are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of salt-tolerant plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the reduced amount of available water resulting from the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare soil surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to buildings and septic tank absorption fields because of the flooding and the wetness. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat ranges from 31 to 38, depending on the degree of drainage. The range site is Saline Lowland.

23F—Buse-Barnes loams, 15 to 35 percent slopes. These deep, well drained soils are on till plains and moraines. The hilly and steep Buse soil is on knobs. The hilly Barnes soil is on side slopes. Individual areas range from 10 to 80 acres in size. They are 50 to 60 percent Buse loam and 25 to 35 percent Barnes loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Buse soil has a black loam surface layer about 6 inches thick. The subsoil is loam about 15 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The next layer is grayish brown, mottled loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled loam. In places the surface layer is eroded and is dark grayish brown.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 22 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In places the surface layer is eroded and is very dark grayish brown.

Included with these soils in mapping are small areas of Hamerly, Lamoure, Renshaw, Sioux, and Svea soils. Also included are some moderately sloping and strongly sloping areas and a few stony areas. Included areas make up about 15 percent of the unit. The somewhat poorly drained Hamerly soils are on flats. They are highly calcareous. Lamoure soils are poorly drained and are in drainageways. Renshaw soils have a gravelly substratum. They occur as areas intermingled with areas of the Barnes soil. The excessively drained Sioux soils are on knobs and ridges. They have a gravelly substratum. The moderately well drained Svea soils are in swales. They are dark to a depth of 16 inches or more.

Permeability is moderately slow in the Buse and Barnes soils. Runoff is very rapid. Available water capacity is high. Organic matter content is moderately low in the Buse soil and high in the Barnes soil.

Most areas are used for pasture, range, or wildlife habitat. These soils are best suited to range. They generally are unsuited to cultivated crops because of the very severe hazard of water erosion and the slope. The important range plants on these soils are little bluestem, western wheatgrass, and needleandthread. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Maintaining an adequate

cover of the important plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field. The slope is a limitation on sites for buildings and absorption fields. The buildings and absorption fields can be designed so that they conform to the natural slope of the land.

The land capability classification of the Buse soil is VIIe, and that of the Barnes soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Barnes soil is Silty.

26—Colvin silty clay loam. This deep, level, poorly drained, highly calcareous soil is on flats and in swales on lake plains. Individual areas range from 5 to 80 acres in size.

Typically, the surface soil is black silty clay loam about 11 inches thick. The next layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil is grayish brown, mottled silty clay loam about 6 inches thick. The next layer is grayish brown, mottled silty clay loam about 9 inches thick. The substratum to a depth of about 60 inches is mottled. It is grayish brown silty clay loam in the upper part, gray sandy loam in the next part, and gray silty clay loam in the lower part. In some places the surface layer is silt loam. In other places it contains salt crystals. In some areas lime has not accumulated within a depth of 16 inches.

Included with this soil in mapping are small areas of Bearden soils. Also included, in depressions, are small areas of some other poorly drained soils that have a silty clay or clay subsoil. Included soils make up about 20 percent of the unit. The somewhat poorly drained Bearden soils are on rises. They have a light olive brown substratum.

Permeability is moderately slow in the Colvin soil, and runoff is very slow. A seasonal high water table is between the surface and a depth of 1 foot. Available water capacity and organic matter content are high. Tilth is fair.

Most areas are used for cultivated crops, but some are used for hay or wetland wildlife. If drained, this soil is suited to small grain, flax, and sunflowers. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. In undrained areas, wetness delays or prevents tillage, seeding, or harvesting and crops are harvested in only about 5 to 7 years out of 10. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife. Incorporating organic material into the surface layer helps to maintain and improve tilth.

The important range plants on this soil are slim sedge, wooly sedge, and prairie cordgrass. Creeping foxtail, reed canarygrass, switchgrass, and alsike clover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred when the soil is wet.

Drained areas of this soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to buildings and septic tank absorption fields because of the wetness. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 41 to 71, depending on the degree of drainage. The range site is Wet Meadow.

27—Divide loam. This deep, level, somewhat poorly drained, highly calcareous soil is on flats and in swales on outwash plains. Individual areas range from 10 to 70 acres in size.

Typically, the surface soil is black loam about 11

inches thick. The subsoil is loam about 17 inches thick. It is dark grayish brown in the upper part and grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown gravelly coarse sand.

Included with this soil in mapping are small areas of Colvin, Fordville, Hamerly, Marysland, and Renshaw soils. These soils make up about 20 percent of the unit. The poorly drained Colvin soils are in swales. They have a silty clay loam surface layer and subsoil. The well drained Fordville soils are on rises. The somewhat poorly drained Hamerly soils have a loam substratum. They occur as areas intermingled with areas of the Divide soil. The poorly drained Marysland soils are in swales. They are dark grayish brown in the lower part of the substratum. The excessively drained Renshaw soils are on rises.

Permeability is moderate in the upper part of the Divide soil and very rapid in the lower part. Runoff is slow. A seasonal high water table is at a depth of 2.5 to 5.0 feet. Available water capacity is moderate. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on this soil are little bluestem and big bluestem. Tall wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings, but it is poorly suited to septic tank absorption fields. A surface and foundation drainage system helps to prevent seepage into basements. Because of the very rapid permeability, the soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution and also helps to reduce the effects of the seasonal high water table. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIs. The productivity index for spring wheat is 65. The range site is Limy Subirrigated.

31B—Egeland fine sandy loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on rises on lake plains. Individual areas range from 10 to 100 acres in size.

Typically, the surface layer is very dark gray fine sandy loam about 9 inches thick. The subsoil is fine sandy loam about 31 inches thick. It is dark grayish brown in the upper part, olive brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown fine sandy loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with this soil in mapping are small areas of Gardena, Lanona, and Svea soils. Also included are small areas of poorly drained soils in depressions. Included soils make up about 10 percent of the unit. The moderately well drained Gardena soils have a silt loam surface soil and subsoil. The well drained Lanona soils have a loam substratum. Gardena and Lanona soils occur as areas intermingled with areas of the Egeland soil. The moderately well drained Svea soils have a loam surface layer and subsoil. They are in swales.

Permeability is moderately rapid in the Egeland soil, and runoff is slow. Available water capacity is moderate. Organic matter content also is moderate. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain, corn, and sunflowers; however, it is somewhat droughty. It is particularly well suited to rye and winter wheat, which make the best use of the early season moisture supply and help to control soil blowing in fall, winter, and spring. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, buffer strips, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome the droughtiness by

trapping snow and thus increasing the moisture supply.

The important range plants on this soil are needleandthread and prairie sandreed. Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants at a height that traps snow helps to store water in the soil and to control soil blowing. Denuding can occur along cattle trails and in areas where cattle congregate. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soil is somewhat droughty, and trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing in the season prior to planting because of the moderate available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is well suited to buildings and septic tank absorption fields. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 61. The range site is Sandy.

36—Fargo silty clay. This deep, level, poorly drained soil is on flats on lake plains. Individual areas range from 20 to 80 acres in size.

Typically, the surface layer is black silty clay about 8 inches thick. The subsoil is silty clay about 29 inches thick. It is very dark brown in the upper part and dark grayish brown in the lower part. It is mottled at a depth of 30 to 37 inches. The substratum to a depth of about 60 inches is mottled. It is olive gray silty clay in the upper part and olive gray clay in the lower part. In places the surface layer is calcareous.

Included with this soil in mapping are small areas of Dovray and Lismore soils. Also included are some areas of poorly drained soils that have a dense, alkali subsoil. They are intermingled with areas of the Fargo soil. Included soils make up about 10 percent of the unit. The very poorly drained Dovray soils are in depressions. They are dark to a depth of more than 24 inches. The moderately well drained Lismore soils are on swells.

Permeability is slow in the Fargo soil, and runoff is very slow. A seasonal high water table is between the surface and a depth of 3 feet. Available water capacity and organic matter content are high. Tilth is poor.

Most areas are used for cultivated crops. If drained, this soil is suited to small grain, corn, and sunflowers. A system of constructed drains removes surface water from most areas and increases the suitability for crops. In undrained areas the wetness usually delays or prevents seeding and harvesting. The main concerns in managing cultivated areas are maintaining or improving tilth and workability and maintaining drainage channels. Tillage when the soil is neither too wet nor too dry helps to prevent surface compaction and improves tilth. Plowing in the fall leaves the soil in good condition for seedbed preparation in the spring; however, it increases the hazard of soil blowing. The hazard of soil blowing is moderate. A system of conservation tillage that leaves crop residue on the surface, field windbreaks, and buffer strips help to control soil blowing.

The important range plants on this soil are western wheatgrass and green needlegrass. Creeping foxtail, reed canarygrass, switchgrass, and alsike clover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred when the soil is wet.

Drained areas of this soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover can improve the survival and growth rates of the seedlings.

This soil is poorly suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements. The slow permeability and the seasonal high water table are limitations on sites for septic tank absorption fields. A mound system helps to overcome these limitations.

The land capability classification is IIw. The

productivity index for spring wheat ranges from 42 to 88, depending on the degree of drainage. The range site is Clayey.

40B—Gardena-Zell silt loams, 3 to 6 percent slopes. These deep, gently sloping soils are on lake plains. The moderately well drained Gardena soil is in swales. The well drained Zell soil is on rises. Individual areas range from 20 to 40 acres in size. They are 50 to 75 percent Gardena silt loam and 20 to 45 percent Zell silt loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Gardena soil has a silt loam surface soil about 24 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is silt loam about 20 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown. It is silt loam in the upper part and stratified silt loam and very fine sandy loam in the lower part. In places the dark color of the surface soil extends to a depth of only 8 to 16 inches.

Typically, the Zell soil has a very dark gray silt loam surface layer about 8 inches thick. The subsoil is light olive brown silt loam about 15 inches thick. The substratum to a depth of about 60 inches is light olive brown silt loam.

Included with these soils in mapping are small areas of the highly calcareous Glyndon soils in swales. These included soils make up about 5 percent of the unit.

Permeability is moderate in the Gardena and Zell soils. Runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet in the Gardena soil. Organic matter content is high in the Gardena soil and moderate in the Zell soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The hazard of soil blowing is slight on the Gardena soil and moderate on the Zell soil. The hazard of water erosion is moderate on both soils. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help to control soil blowing and water erosion.

The important range plants on these soils are western wheatgrass, needleandthread, little bluestem, and green needlegrass. Smooth bromegrass, big bluestem, western wheatgrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for pasture or range.

The Gardena soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. The Zell soil is suited only to the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings. The Zell soil is suited to septic tank absorption fields, but the Gardena soil is poorly suited. A surface and foundation drainage system helps to prevent seepage into basements in areas of the Gardena soil. The seasonal high water table is a limitation if the Gardena soil is used as a site for septic tank absorption fields. A mound system helps to overcome this limitation. The moderate permeability is a limitation if the Zell soil is used as a site for septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification of the Gardena soil is IIe, and that of the Zell soil is IIIe. The productivity index of the unit for spring wheat is 74. The range site of the Gardena soil is Silty, and that of the Zell soil is Thin Upland.

40C—Zell silt loam, 6 to 9 percent slopes. This deep, moderately sloping, well drained soil is on side slopes on truncated lake plains. Individual areas range from 5 to 40 acres in size.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsoil is light olive brown, calcareous silt loam about 15 inches thick. The next layer is light olive brown, calcareous very fine sandy loam about 11 inches thick. The substratum to a depth of about 60 inches is light olive brown, calcareous very fine sandy loam.

Included with this soil in mapping are small areas of Egeland, Gardena, and Glyndon soils. Also included are areas of some other well drained soils that have a dark brown, noncalcareous subsoil. Included soils make up about 30 percent of the unit. The well drained Egeland soils have a fine sandy loam subsoil. They occur as areas intermingled with areas of the Zell soil. The moderately well drained Gardena soils are in swales. They are dark to a depth of 16 inches or more. The somewhat poorly drained Glyndon soils are in swales and drainageways. The soils that have a dark brown

subsoil occur as areas intermingled with areas of the Zell soil.

Permeability is moderate in the Zell soil, and runoff is medium. Available water capacity is high. Organic matter content is moderate. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain, corn, and sunflowers. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The hazard of soil blowing is moderate, and the hazard of water erosion is severe. A system of conservation tillage that leaves crop residue on the surface, windbreaks, buffer strips, and grassed waterways in areas where runoff concentrates help to control soil blowing and water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on this soil are little bluestem, western wheatgrass, and needleandthread. Smooth bromegrass, green needlegrass, western wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil is suited to only the most drought-tolerant species of trees and shrubs grown as windbreaks and environmental plantings. Optimum growth, survival, and vigor are unlikely. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is well suited to buildings and is suited to septic tank absorption fields. The moderate permeability is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification is IVe. The productivity index for spring wheat is 41. The range site is Thin Upland.

40E—Zell silt loam, 9 to 25 percent slopes. This deep, strongly sloping and moderately steep, well drained soil is on side slopes on truncated lake plains. Individual areas range from 5 to 40 acres in size.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsoil is light olive brown, calcareous silt loam about 15 inches thick. The next layer is light olive brown, calcareous very fine sandy loam about 11 inches thick. The substratum to a depth of about 60 inches is light olive brown, calcareous very fine sandy loam. In places the soil contains less silt and more sand and clay.

Included with this soil in mapping are small areas of Gardena soils. Also included are areas of some other well drained soils. Included soils make up about 15 percent of the unit. The moderately well drained Gardena soils are in swales. They are dark to a depth of 16 inches or more. The other well drained soils have a dark brown, noncalcareous subsoil. They occur as areas intermingled with areas of the Zell soil.

Permeability is moderate in the Zell soil, and runoff is medium. Available water capacity is high. Organic matter content is moderate.

Most areas are used for pasture, but some are used for cultivated crops. This soil is best suited to pasture, range, and hay. It generally is unsuited to cultivated crops because of the hazard of erosion and the slope. The hazard of soil blowing is moderate, and the hazard of water erosion is very severe.

The important range plants on this soil are needleandthread, little bluestem, and western wheatgrass. Smooth bromegrass, green needlegrass, western wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

This soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

This soil is suited to buildings and septic tank absorption fields. The slope is a limitation on sites for buildings and absorption fields. The buildings and absorption fields can be designed so that they conform to the natural slope of the land. The moderate permeability is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification is VIIe. The productivity index for spring wheat is 0. The range site is Thin Upland.

43—Gardena silt loam. This deep, level, moderately well drained soil is on flats on lake plains. Individual areas range from 20 to 200 acres in size.

Typically, the surface soil is silt loam about 24 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is silt loam about 20 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown. It is silt loam in the upper part and stratified silt loam and very fine sandy loam in the lower part. In places the substratum is loam or clay loam.

Included with this soil in mapping are small areas of Egeland, Glyndon, and Overly soils. These soils make up about 10 percent of the unit. The well drained Egeland soils are on rises. They have a fine sandy loam subsoil. The somewhat poorly drained Glyndon soils are in swales. They are highly calcareous. The moderately well drained Overly soils have a silty clay loam surface layer and subsoil. They occur as areas intermingled with areas of the Gardena soil.

Permeability is moderate in the Gardena soil, and runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet. Available water capacity is very high, and organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, corn, sunflowers, and soybeans. The main concerns in managing cultivated areas are controlling soil blowing and maintaining tilth and fertility. The hazard of soil blowing is slight; however, soil blowing does occur during some storms. The hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing. Incorporating organic material into the surface layer helps to maintain tilth and fertility.

The important range plants on this soil are western wheatgrass and needleandthread. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of this soil for range or pasture.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings.

This soil is suited to buildings, but it is poorly suited to septic tank absorption fields. A surface and foundation drainage system helps to prevent seepage into basements. The seasonal high water table is a limitation on sites for septic tank absorption fields. A mound system helps to overcome this limitation.

The land capability classification is IIe. The productivity index for spring wheat is 99. The range site is Silty.

46—Gardena-Glyndon silt loams, 0 to 3 percent slopes. These deep, level and nearly level soils are on lake plains. The moderately well drained Gardena soil is on rises. The somewhat poorly drained, highly calcareous Glyndon soil is in swales. Individual areas range from 20 to 200 acres in size. They are 45 to 60 percent Gardena silt loam and 30 to 45 percent Glyndon silt loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Gardena soil has a silt loam surface soil about 24 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is silt loam about 20 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown. It is silt loam in the upper part and stratified silt loam and very fine sandy loam in the lower part.

Typically, the Glyndon soil has a black silt loam surface soil about 11 inches thick. The subsoil is silt loam about 17 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The upper part of the substratum is light yellowish brown, mottled silt loam. The lower part to a depth of about 60 inches is light olive brown very fine sandy loam. In some places the surface soil is loam. In other places the subsoil and substratum are loam or fine sandy loam.

Included with these soils in mapping are small areas of Colvin and Overly soils. Also included are areas of some poorly drained soils in depressions. Included soils make up about 15 percent of the unit. The poorly drained Colvin soils are in swales. They have a silty clay loam surface layer and subsoil. The well drained Overly soils have a silty clay loam subsoil. They occur as areas intermingled with areas of the Gardena soil. The poorly drained soils are mottled within a depth of 24 inches.

Permeability is moderate in the Gardena and Glyndon soils. Runoff is slow. Available water capacity is very high in the Gardena soil and high in the Glyndon soil. A seasonal high water table is at a depth of 4 to 6 feet in the Gardena soil and at a depth of 2.5 to 6.0 feet in the Glyndon soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are well suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on these soils are western wheatgrass, needleandthread, little bluestem, and big bluestem. Big bluestem, switchgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. They have no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings but are poorly suited to septic tank absorption fields. A surface and foundation drainage system helps to prevent seepage into basements. The seasonal high water table is a limitation on sites for septic tank absorption fields. A mound system helps to overcome this limitation. If shallow excavations, such as those for basements, are dug in areas of the Glyndon soil, the sides tend to cave in unless they are shored.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 96. The range site of the Gardena soil is Silty, and that of the Glyndon soil is Limy Subirrigated.

48—Glyndon silt loam. This deep, level, somewhat poorly drained, highly calcareous soil is on flats on lake plains. Individual areas range from 20 to 200 acres in size.

Typically, the surface layer is black silt loam about 8 inches thick. The next layer is very dark brown silt loam about 3 inches thick. The subsoil is silt loam about 17 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The upper part of the substratum is light yellowish brown silt loam. The next part is light olive brown, mottled silt loam. The lower part to a depth of about 60 inches is light olive brown, mottled very fine sandy loam. In some places the surface layer is loam. In other places the subsoil and substratum are loam.

Included with this soil in mapping are small areas of Colvin and Gardena soils. Also included are areas of some poorly drained soils in depressions. Included soils make up about 25 percent of the unit. The poorly drained Colvin soils are in swales. They have a silty clay loam subsoil. The moderately well drained Gardena soils are on rises. They are dark to a depth of 16 inches or more. The poorly drained soils are mottled within a depth of 24 inches.

Permeability is moderate in the Glyndon soil, and runoff is slow. A seasonal high water table is at a depth of 2.5 to 6.0 feet. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, corn, soybeans, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on this soil are little bluestem and big bluestem. Tall wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings, but it is poorly suited to septic tank absorption fields. A surface and foundation drainage system helps to prevent seepage into basements. The seasonal high water table is a limitation on sites for septic tank absorption fields. A mound system helps to overcome this limitation. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIe. The

productivity index for spring wheat is 95. The range site is Limy Subirrigated.

49—Glyndon silt loam, saline, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained, highly calcareous, moderately saline soil is on flats on lake plains. Individual areas range from about 10 to 200 acres in size.

Typically, the surface layer is black silt loam about 9 inches thick. It contains salt crystals. The subsoil is silt loam about 29 inches thick. It is grayish brown in the upper part and light olive brown and mottled in the lower part. The substratum extends to a depth of about 60 inches. It is dark brown, mottled silt loam in the upper part and light olive brown, stratified silt loam and very fine sandy loam in the lower part. In some places the surface layer is loam. In other places it does not contain salt crystals.

Included with this soil in mapping are small areas of Colvin and Gardena soils. Also included are areas of some poorly drained soils in depressions. Included soils make up about 25 percent of the unit. The poorly drained Colvin soils are in swales. They have a silty clay loam surface layer and subsoil. The moderately well drained Gardena soils have a silty clay loam surface layer and subsoil. They occur as areas intermingled with areas of the Glyndon soil. The poorly drained soils have mottles within a depth of 24 inches.

Permeability is moderate in the Glyndon soil, and runoff is slow. A seasonal high water table is at a depth of 2.5 to 6.0 feet. Available water capacity is moderate. Organic matter content is high. Tilth is fair. Salts reduce the amount of water available to plants.

Most areas are used for cultivated crops. This soil is poorly suited to small grain, corn, and sunflowers because of the salinity. It is best suited to salt-tolerant crops, hay, pasture, and range. Continuous cropping helps to control salt accumulation in the surface layer by reducing the evaporation rate at the surface. Wetness delays tillage and seeding in the spring of some years but does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, annual buffer strips, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on this soil are western wheatgrass, inland saltgrass, and Nuttall alkaligrass. Tall wheatgrass, alkali sacaton, and sweetclover are suitable hay and pasture plants. The high salt content, soil blowing, and the limited amount of available water in the soil are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable salt-tolerant plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the reduced amount of available water resulting from the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare soil surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect seedlings from abrasion.

This soil is suited to buildings, but it is poorly suited to septic tank absorption fields. A surface and foundation drainage system helps to prevent seepage into basements. The seasonal high water table is a limitation on sites for septic tank absorption fields. A mound system helps to overcome this limitation. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIs. The productivity index for spring wheat is 59. The range site is Saline Lowland.

50—Hamerly-Tonka complex, 0 to 3 percent slopes. These deep soils are on till plains. The somewhat poorly drained, level and nearly level, highly calcareous Hamerly soil is on flats and between and surrounding depressions. The poorly drained, level Tonka soil is in the depressions. It is subject to ponding. Individual areas range from 5 to 200 acres in size. They are 50 to 60 percent Hamerly loam and 25 to 35 percent Tonka silt loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Hamerly soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 30 inches thick. It is grayish brown in the upper part and light olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the substratum is dark gray. In other places the substratum is silt loam. In some areas lime is below a depth of 16 inches.

Typically, the Tonka soil has a black silt loam surface soil about 13 inches thick. The subsurface layer is dark

grayish brown, mottled silt loam about 5 inches thick. The subsoil is about 21 inches thick. It is dark grayish brown clay loam in the upper part; olive gray, mottled clay in the next part; and dark grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled silt loam.

Included with these soils in mapping are small areas of Barnes, Svea, Vallers, and Wyard soils. Also included are some small areas of saline soils on rises. Included soils make up about 15 percent of the unit. The well drained Barnes soils and the moderately well drained Svea soils are on rises. They are not highly calcareous. The poorly drained Vallers soils are on flats and rims of depressions. They have a dark gray substratum. The somewhat poorly drained Wyard soils are in swales and depressions. They are mottled within a depth of 24 inches.

Permeability is moderately slow in the Hamerly soil and slow in the Tonka soil. Runoff is slow on the Hamerly soil and ponded on the Tonka soil. Available water capacity is high in both soils. A seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil and 6 inches above the surface to 1 foot below in the Tonka soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops, but some are used for hay, range, or wetland wildlife habitat. The Hamerly soil and drained areas of the Tonka soil are suited to small grain and sunflowers. Locating suitable drainage outlets generally is difficult. As a result, few areas of the Tonka soil are drained. In undrained areas of the Tonka soil, the ponding frequently delays tillage, seeding, or harvesting and crops are harvested in only about 5 to 7 years out of 10. The hazard of soil blowing is moderate on the Hamerly soil and slight on the Tonka soil. The hazard of water erosion is slight on both soils. A system of conservation tillage that leaves crop residue on the surface, stripcropping, buffer strips, and field windbreaks help to control soil erosion. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife. The Tonka soil and the ponded water provide breeding areas and habitat for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The important range plants on these soils are big bluestem, little bluestem, wooly sedge, and prairie cordgrass. Creeping foxtail, reed canarygrass, big bluestem, and switchgrass are suitable hay and pasture plants. Soil blowing is a hazard on the Hamerly soil, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing. Compaction, trampling, and root shearing are hazards, especially in areas of the Tonka soil if the range or pasture is grazed when the soil is wet. Grazing should be deferred when the Tonka soil is wet.

The Hamerly soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Drained areas of the Tonka soil are suited to all of the adapted species. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The Hamerly soil is poorly suited to septic tank absorption fields and buildings. The seasonal high water table is a limitation on sites for septic tank absorption fields. A mound system helps to overcome this limitation. The moderate shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements. The Tonka soil generally is unsuited to these uses because of the ponding. The Hamerly soil in this unit and other nearby soils generally are better suited to these uses.

The land capability classification of the Hamerly soil is IIe, and that of the Tonka soil is IIw. The productivity index of the unit for spring wheat is 84. The range site of the Hamerly soil is Limy Subirrigated, and that of the Tonka soil is Wet Meadow.

54—Lamoure silt loam, channeled. This deep, level, poorly drained soil is on flats on flood plains (fig. 7). It is subject to flooding. Most areas are dissected by channels or steep escarpments. Individual areas range from 5 to 300 acres in size.

Typically, the surface soil is about 40 inches thick. It is black silt loam in the upper part and very dark gray silty clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled silty clay loam. In some places the surface layer is loam or silty clay loam. In other places the surface soil and

Figure 7.—An area of Lamoure silt loam, channeled.

substratum are silty clay. In some areas the soil contains salt crystals.

Included with this soil in mapping are small areas of Colvin and Marysland soils. Also included are areas of some very poorly drained soils in oxbows and some small areas of saline soils. Included soils make up about 20 percent of the unit. The poorly drained Colvin and Marysland soils have accumulated lime in the subsoil. They occur as areas intermingled with areas of the Lamoure soil.

Permeability is moderate in the Lamoure soil, and runoff is slow. A seasonal high water table is between the surface and a depth of 2 feet. Available water capacity and organic matter content are high.

Most areas are used for pasture, range, or hay. This soil generally is unsuited to cultivated crops and to trees and shrubs because of wetness and the small size of the arable areas. It is best suited to range and pasture. The wetness interferes with haying in some years.

The important range plants on this soil are big bluestem and porcupinegrass. Intermediate wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for range or pasture.

This soil generally is unsuited to buildings and septic tank absorption fields because of the flooding and the wetness. Better sites generally are nearby.

The land capability classification is VIw. The productivity index for spring wheat is 0. The range site is Subirrigated.

56—LaDelle silty clay loam. This deep, level, moderately well drained soil is on flats on flood plains. It

is subject to flooding. Individual areas range from about 10 to 250 acres in size.

Typically, the surface soil is silty clay loam about 11 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is very dark gray silty clay loam about 6 inches thick. The next layer is very dark gray silty clay loam about 13 inches thick. The substratum to a depth of about 60 inches is very dark grayish brown, stratified silty clay loam and silt loam.

Included with this soil in mapping are small areas of Lamoure and Sinai soils. Also included are areas of some soils that have more sand throughout than the LaDelle soil. They are intermingled with areas of the LaDelle soil. Included soils make up about 25 percent of the unit. The poorly drained Lamoure soils are in swales. The well drained Sinai soils are on rises. They have a silty clay substratum.

Permeability is moderate in the LaDelle soil, and runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet. Available water capacity is very high, and organic matter content is high. Tilth is fair.

Most areas are used as grazeable woodland. Some areas are used for cultivated crops. This soil is suited to small grain, corn, sunflowers, and soybeans. The main concern in managing cultivated areas is maintaining or improving tilth and fertility. The hazards of soil blowing and water erosion are slight. Tillage when the soil is neither too wet nor too dry helps to prevent surface compaction and improves tilth. Returning crop residue to the soil also helps to improve tilth and fertility.

The important range plants on this soil are big bluestem, green needlegrass, and western wheatgrass. Big bluestem, smooth bromegrass, intermediate wheatgrass, and alfalfa are suitable hay and pasture plants. Scouring during flooding is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control scouring.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings.

This soil generally is unsuited to buildings and septic tank absorption fields because of the flooding. Better sites generally are nearby.

The land capability classification is IIc. The productivity index for spring wheat is 96. The range site is Overflow.

62—Overly-Bearden silty clay loams. These deep, level soils are on lake plains. The moderately well drained Overly soil is on rises. The somewhat poorly drained, highly calcareous Bearden soil is in swales. Individual areas range from 30 to 600 acres in size. They are 65 to 80 percent Overly silty clay loam and 15 to 30 percent Bearden silty clay loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Overly soil has a black silty clay loam surface layer about 8 inches thick. The subsoil is silty clay loam about 29 inches thick. In sequence downward, it is black, dark grayish brown, grayish brown and mottled, and light olive brown and mottled. The upper part of the substratum is light olive brown, mottled silty clay loam. The lower part to a depth of about 60 inches is light brownish gray, mottled very fine sandy loam. In places the dark color of the surface layer extends to a depth of only 9 to 16 inches.

Typically, the Bearden soil has a black silty clay loam surface layer about 9 inches thick. The subsoil is silty clay loam about 23 inches thick. It is grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown and mottled. It is silty clay loam in the upper part and silt loam in the lower part. In some places the surface layer is silt loam or loam. In other places the subsoil and substratum are loam.

Included with these soils in mapping are small areas of Fordville and Gardena soils. These included soils make up about 10 percent of the unit. The well drained Fordville soils are on rises. They have a very gravelly sand substratum. The moderately well drained Gardena soils have a silt loam surface layer and subsoil. They occur as areas intermingled with areas of the Overly soil.

Permeability is moderately slow in the Overly and Bearden soils. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet in the Overly soil and at a depth of 2 to 4 feet in the Bearden soil. Organic matter content is high in both soils. Tilth is fair.

Most areas are used for cultivated crops. These soils are well suited to small grain, corn, soybeans, and sunflowers. The main concerns in managing cultivated areas are controlling soil blowing and maintaining or improving tilth. The hazard of soil blowing is slight on the Overly soil and moderate on the Bearden soil. The hazard of water erosion is slight on both soils. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help to control

soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Incorporating organic material into the surface layer improves or helps to maintain tilth.

The important range plants on these soils are western wheatgrass, needlegrass, little bluestem, and big bluestem. Big bluestem, switchgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. They have no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are poorly suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements. The moderately slow permeability and the seasonal high water table are limitations on sites for septic tank absorption fields. A mound system helps to overcome these limitations.

The land capability classification of the Overly soil is IIc, and that of the Bearden soil is IIe. The productivity index of the unit for spring wheat is 98. The range site of the Overly soil is Silty, and that of the Bearden soil is Limy Subirrigated.

63—Renshaw loam, 0 to 2 percent slopes. This deep, level and nearly level, somewhat excessively drained soil is on flats on outwash plains and terraces. Individual areas range from about 10 to 70 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is very dark grayish brown loam about 8 inches thick. The substratum to a depth of about 60 inches is gravelly coarse sand. It is dark brown in the upper part and grayish brown in the lower part. In the Stoney Slough drainage area, as much as 25 percent of the gravel in the substratum is shale fragments.

Included with this soil in mapping are small areas of Divide, Fordville, and Sioux soils. Also included are a few small areas of soils that are stony. Included soils make up about 25 percent of the unit. The somewhat poorly drained Divide soils are in swales. They have accumulated lime in the subsoil. The well drained Fordville soils have sand at a depth of about 33 inches. They occur as areas intermingled with areas of the Renshaw soil. The excessively drained Sioux soils are on knolls and ridges. They have very gravelly coarse sand at a depth of about 8 inches.

Permeability is moderate in the upper part of the Renshaw soil and rapid in the lower part. Runoff is slow. Available water capacity is low. Organic matter content is moderate. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. It is particularly well suited to rye and winter wheat, which make the best use of the early season moisture supply and help to control soil blowing in fall, winter, and spring. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. The hazards of soil blowing and water erosion are slight; however, soil blowing can occur during some windstorms. A system of conservation tillage that leaves crop residue on the surface, annual buffer strips, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome the droughtiness. The stubble traps snow and thus increases the moisture supply. Because of the low available water capacity, fallowing is of limited value. It increases the hazard of soil blowing.

The important range plants on this soil are needleandthread and western wheatgrass. Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important plants or of other suitable plants at a height that traps snow helps to store water in the soil and thus helps to control soil blowing. Because of soil blowing, denuding can occur along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress.

Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing in the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is well suited to buildings, but it is poorly suited to septic tank absorption fields. Because of the rapid permeability, the soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIs. The productivity index for spring wheat is 48. The range site is Shallow to Gravel.

64—Pits, gravel. This unit is in areas from which the soil has been removed and the underlying sand and gravel mined. The areas generally support little or no vegetation. They range from about 3 to 35 acres in size.

Many of the pits are abandoned. This unit generally is unsuited to agricultural uses unless the areas are leveled and topdressed with suitable topsoil or otherwise reclaimed. In unreclaimed areas, planting climatically adapted trees and shrubs can enhance wildlife habitat or increase the esthetic value. The suitability for individual species of trees and shrubs varies from pit to pit.

This unit generally is unsuitable as a site for septic tank absorption fields and buildings unless it is leveled and reclaimed. A seasonal high water table is exposed in some areas. Onsite investigation is needed to determine the suitability for any given use.

The capability classification is VIIIs. The productivity index for spring wheat is 0. A range site is not assigned.

65—Svea-Barnes loams, 0 to 2 percent slopes. These deep, level and nearly level soils are on till plains. The moderately well drained Svea soil is in swales. The well drained Barnes soil is on rises. Individual areas range from 5 to 1,200 acres in size. They are 60 to 70 percent Svea loam and 25 to 35 percent Barnes loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Svea soil has a black loam surface soil about 12 inches thick. The subsoil is loam about 31 inches thick. In sequence downward, it is very dark brown, very dark grayish brown, grayish brown, and light brownish gray and mottled. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the soil is mottled within a depth of 24 inches. In other places the surface soil and subsoil contain more silt.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 22 inches thick. In sequence downward, it is very dark grayish brown, dark brown, dark grayish brown, and grayish brown. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Included with these soils in mapping are small areas of Hamerly, Lismore, and Swenoda soils. Also included are a few small areas of soils that are stony. Included soils make up about 5 percent of the unit. The somewhat poorly drained Hamerly soils are on flats. They are highly calcareous. The moderately well drained Lismore soils have a silty clay loam surface soil. The moderately well drained Swenoda soils have a fine sandy loam surface layer. Lismore and Swenoda soils occur as areas intermingled with areas of the Svea soil.

Permeability is moderately slow in the Svea and Barnes soils. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are well suited to small grain, corn, and sunflowers. The main concern in managing cultivated areas is maintaining tilth and fertility. The hazards of water erosion and soil blowing are slight. A system of conservation tillage that leaves crop residue on the surface helps to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Incorporating organic material into the surface layer improves or helps to maintain tilth and fertility.

The important range plants on these soils are big bluestem, porcupinegrass, and green needlegrass. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for range or pasture.

The Svea soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. The Barnes soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before

the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements in areas of the Svea soil. The moderately slow permeability is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table is a limitation if the Svea soil is used as a site for septic tank absorption fields. A mound system helps to overcome this limitation.

The land capability classification of both soils is IIc. The productivity index of the unit for spring wheat is 95. The range site of the Svea soil is Overflow, and that of the Barnes soil is Silty.

66—Hamerly-Wyard loams, 0 to 3 percent slopes. These deep, somewhat poorly drained soils are on till plains. The nearly level, highly calcareous Hamerly soil is on flats between and surrounding depressions. The nearly level Wyard soil is in swales and slight depressions. Individual areas range from 5 to 200 acres in size. They are 55 to 70 percent Hamerly loam and 20 to 35 percent Wyard loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Hamerly soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 30 inches thick. It is grayish brown in the upper part and light olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the substratum is dark gray. In other places the substratum is silt loam.

Typically, the Wyard soil has a black loam surface soil about 23 inches thick. The subsoil is loam about 18 inches thick. It is dark grayish brown and mottled in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam.

Included with these soils in mapping are small areas of Svea, Tonka, and Vallers soils. Also included are some small areas of saline soils. Included soils make up about 10 percent of the unit. The moderately well drained Svea soils are on rises. They are not highly calcareous. The poorly drained Tonka soils are in depressions. They have accumulated clay in the subsoil. The poorly drained Vallers soils are on flats and on the rims of the depressions. They have a dark gray substratum.

Permeability is moderately slow in the Hamerly soil and moderate in the Wyard soil. Runoff is slow on both soils. It flows onto the Wyard soil from the higher areas. Available water capacity is high in both soils. A seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil and at a depth of 1 to 3 feet in the Wyard soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops, but some are used for hay, range, or wetland wildlife habitat. These soils are well suited to small grain and sunflowers. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate on the Hamerly soil and slight on the Wyard soil. The hazard of water erosion is slight on both soils. A system of conservation tillage that leaves crop residue on the surface, stripcropping, buffer strips, and field windbreaks help to control soil erosion. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

The important range plants are big bluestem, little bluestem, and prairie cordgrass. Creeping foxtail, big bluestem, switchgrass, and smooth bromegrass are suitable hay and pasture plants. Soil blowing is a hazard on the Hamerly soil, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. They have no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings, but they are poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements in areas of the Hamerly soil. The seasonal high water table in both soils is a limitation on sites for septic tank absorption fields. A

mound system helps to overcome this limitation.

The land capability classification of the Hamerly soil is IIe, and that of the Wyard soil is IIw. The productivity index of the unit for spring wheat is 87. The range site of the Hamerly soil is Limy Subirrigated, and that of the Wyard soil is Overflow.

66B—Hamerly loam, 3 to 6 percent slopes. This deep, gently sloping, somewhat poorly drained, highly calcareous soil is on flats on till plains. Individual areas range from 10 to 60 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 30 inches thick. It is grayish brown in the upper part and light olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the substratum is grayish brown. In other places it is silt loam. In some areas the soil is saline.

Included with this soil in mapping are small areas of Barnes, Buse, Tonka, Vallers, and Wyard soils. These soils make up about 25 percent of the unit. The well drained Barnes soils are on rises. They are noncalcareous in the upper part of the subsoil. The well drained Buse soils are on knobs. The poorly drained Tonka soils are in depressions. They have accumulated clay in the subsoil. The poorly drained Vallers soils are on the rims of the depressions. They have a dark gray substratum. The somewhat poorly drained Wyard soils are in swales. They have a dark surface layer extending to a depth of 16 inches or more and have a mottled subsoil.

Permeability is moderately slow in the Hamerly soil, and runoff is medium. A seasonal high water table is at a depth of 2 to 4 feet. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain and corn. The main concern in managing cultivated areas is controlling soil blowing and water erosion. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazards of soil blowing and water erosion are moderate. A system of conservation tillage that leaves crop residue on the surface, stripcropping, buffer strips, and field windbreaks help to control soil blowing and water erosion. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

The important range plants on this soil are little bluestem and big bluestem. Tall wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing and water erosion.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings, but it is poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements. The moderately slow permeability and the seasonal high water table are limitations on sites for septic tank absorption fields. A mound system helps to overcome these limitations.

The land capability classification is IIe. The productivity index for spring wheat is 75. The range site is Limy Subirrigated.

67C—Renshaw-Sioux loams, 2 to 9 percent slopes. These deep, undulating and gently rolling soils are on outwash plains and terraces. The somewhat excessively drained Renshaw soil is on side slopes. The excessively drained Sioux soil is on knolls and ridges. Individual areas range from 10 to 70 acres in size. They are 55 to 65 percent Renshaw loam and 25 to 35 percent Sioux loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Renshaw soil has a black loam surface layer about 8 inches thick. The subsoil is very dark grayish brown loam about 8 inches thick. The substratum to a depth of about 60 inches is gravelly coarse sand. It is dark brown in the upper part and grayish brown in the lower part.

Typically, the Sioux soil has a black loam surface layer about 6 inches thick. The next layer is very dark grayish brown gravelly loam about 2 inches thick. The upper part of the substratum is dark brown very gravelly coarse sand. The lower part to a depth of about 60 inches is dark brown and grayish brown extremely gravelly coarse sand.

Included with these soils in mapping are small areas

of Divide, Fordville, and Gardena soils. These included soils make up about 10 percent of the unit. The somewhat poorly drained Divide soils are in swales. They are highly calcareous. The well drained Fordville soils have sand at a depth of about 33 inches. The moderately well drained Gardena soils have a silt loam surface layer and subsoil. Fordville and Gardena soils occur as areas intermingled with areas of the Renshaw soil.

Permeability is moderate in the upper part of the Renshaw soil and rapid in the lower part. It is rapid in the Sioux soil. Runoff is medium on both soils. Available water capacity is low. Organic matter content is moderate in the Renshaw soil and moderately low in the Sioux soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. The hazards of soil blowing and water erosion are slight; however, soil blowing does occur during some storms. A system of conservation tillage that leaves crop residue on the surface, buffer strips, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. These soils are particularly well suited to rye and winter wheat, which make the best use of the early season moisture supply and help to control soil blowing in fall, winter, and spring. Leaving tall stubble on the surface helps to overcome the droughtiness by trapping snow and storing soil moisture. Fallowing is of limited value because of the low available water capacity. Also, it increases the hazard of soil blowing.

The important range plants on these soils are needleandthread, blue grama, and western wheatgrass. Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important plants or of other suitable plants at a height that traps snow helps to store water in the soil, control soil blowing, and prevent denuding. Denuding can occur along cattle trails because of soil blowing. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

The Renshaw soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing in the season prior to planting because of the limited available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. The Sioux soil generally is unsuited to these uses. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are well suited to buildings, but they are poorly suited to septic tank absorption fields. Because of the rapid permeability, they readily absorb but do not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification of the Renshaw soil is IVe, and that of the Sioux soil is VIs. The productivity index of the unit for spring wheat is 31. The range site of the Renshaw soil is Shallow to Gravel, and that of the Sioux soil is Very Shallow.

68E—Sioux-Renshaw loams, 9 to 25 percent slopes. These deep, rolling to hilly soils are on eskers, kames, and outwash plains. The excessively drained Sioux soil is on knolls and ridges. The somewhat excessively drained Renshaw soil is on side slopes. Individual areas range from 10 to 70 acres in size. They are 60 to 75 percent Sioux loam and 20 to 35 percent Renshaw loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Sioux soil has a black loam surface layer about 6 inches thick. The next layer is very dark grayish brown gravelly loam about 2 inches thick. The upper part of the substratum is dark brown very gravelly coarse sand. The lower part to a depth of about 60 inches is dark brown, grayish brown, and gray extremely gravelly coarse sand.

Typically, the Renshaw soil has a black loam surface layer about 8 inches thick. The subsoil is very dark grayish brown loam about 8 inches thick. The substratum to a depth of about 60 inches is gravelly coarse sand. It is dark brown in the upper part and grayish brown in the lower part.

Included with these soils in mapping are small areas of Barnes, Fordville, and Gardena soils. These included

soils make up about 5 percent of the unit. The well drained Barnes and Fordville soils are intermingled with areas of the Renshaw soil. Barnes soils have a loam substratum. Fordville soils have gravel and sand at a depth of 20 to 40 inches. The moderately well drained Gardena soils are in swales. They have a silt loam surface layer and subsoil.

Permeability is rapid in the Sioux soil. It is moderate in the upper part of the Renshaw soil and rapid in the lower part. Runoff is rapid on both soils. Available water capacity is low. Organic matter content is moderately low in the Sioux soil and moderate in the Renshaw soil.

Most areas are used for pasture, range, or wildlife habitat; however, some are used for cultivated crops. These soils are best suited to range and pasture. They generally are unsuited to cultivated crops because of the droughtiness and the slope. The important range plants on these soils are needleandthread, blue grama, and little bluestem. Western wheatgrass, intermediate wheatgrass, crested wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important plants or of other suitable plants at a height that traps snow helps to store water in the soil, control soil blowing, and prevent denuding. Denuding can occur along cattle trails because of soil blowing. A planned grazing system that controls the pattern of livestock traffic helps to prevent denuding.

These soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

These soils are suited to buildings, but they are poorly suited to septic tank absorption fields. Because of the rapid permeability, these soils readily absorb but do not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The slope is a limitation on sites for buildings and absorption fields. The buildings and absorption fields can be designed so that they conform to the natural slope of the land. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification of the Sioux soil is VIIs, and that of the Renshaw soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Sioux soil is Very Shallow, and that of the Renshaw soil is Shallow to Gravel.

71—Vallers-Parnell complex. These deep, level soils are on till plains. The poorly drained, highly calcareous Vallers soil is on flats between and surrounding depressions. The very poorly drained Parnell soil is in the depressions. It is subject to ponding. Individual areas range from 5 to 200 acres in size. They are 50 to 60 percent Vallers loam and 25 to 40 percent Parnell silty clay loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Vallers soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 25 inches thick. It is dark gray in the upper part, light olive gray in the next part, and olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is dark gray, mottled loam. In some places the surface layer is silt loam, clay loam, or silty clay loam. In other places the soil is saline.

Typically, the Parnell soil has a black silty clay loam surface layer about 8 inches thick. The subsoil is silty clay about 27 inches thick. It is black in the upper part and very dark gray in the lower part. The upper part of the substratum is olive gray, mottled silty clay. The lower part to a depth of about 60 inches is gray, mottled clay loam.

Included with these soils in mapping are small areas of Hamerly, Southam, and Tonka soils. These included soils make up about 15 percent of the unit. The somewhat poorly drained Hamerly soils are on flats. They are highly calcareous and have a light olive brown substratum. The very poorly drained Southam soils are in deep depressions. They have an organic surface layer. The poorly drained Tonka soils are in shallow depressions and on the outer edges of the deeper depressions. They have a silt loam surface layer.

Permeability is moderately slow in the Vallers soil and slow in the Parnell soil. Runoff is very slow on the Vallers soil and ponded on the Parnell soil. Available water capacity is high in both soils. A seasonal high water table is at a depth of 1.0 foot to 2.5 feet in the Vallers soil and is 2 feet above to 2 feet below the surface in the Parnell soil. Organic matter content is high in both soils. Tilth is good.

Some areas are used for cultivated crops. If drained, these soils are suited to small grain and sunflowers. Locating suitable drainage outlets generally is difficult. As a result, only some areas are drained. In undrained areas of the Parnell soil, ponding frequently delays and sometimes prevents tillage, seeding, or harvesting and crops are harvested in only about 1 to 3 years out of

10. The hazard of soil blowing is moderate on the Vallers soil and slight on the Parnell soil. The hazard of water erosion is slight on both soils. Windbreaks and a system of conservation tillage that leaves crop residue on the surface help to control soil blowing. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife. The Parnell soil and the ponded water provide breeding areas and habitat for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

The important range plants are slough sedge, rivergrass, big bluestem, switchgrass, and prairie cordgrass. Creeping foxtail, reed canarygrass, switchgrass, big bluestem, alfalfa, and alsike clover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred when the soil is wet.

Drained areas of these soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils generally are unsuited to buildings and septic tank absorption fields because of the wetness and the ponding. Better sites generally are nearby.

The land capability classification of the Vallers soil is IIw, and that of the Parnell soil is IIIw. The productivity index of the unit for spring wheat ranges from 35 to 73, depending on the degree of drainage. The range site of the Vallers soil is Subirrigated, and that of the Parnell soil is Wetland.

77—Vallers loam, saline. This deep, level, poorly drained, highly calcareous, moderately saline soil is on flats on till plains. Individual areas range from 5 to 50 acres in size.

Typically, the surface layer is black loam about 8 inches thick. It contains salt crystals. The next layer is black loam about 3 inches thick. It also contains salt crystals. The subsoil is very dark grayish brown loam about 24 inches thick. It contains salt crystals in the upper part and gypsum crystals in the lower part. The substratum to a depth of about 60 inches is loam. It is olive gray in the upper part and olive and mottled in the lower part. In some places the surface layer is silt loam or silty clay loam. In other places the soil is only slightly saline. In some areas the substratum is light olive brown.

Included with this soil in mapping are small areas of Marysland, Parnell, and Tonka soils. Also included are a few small areas of soils that are sandy. Included soils make up about 15 percent of the unit. The poorly drained Marysland soils are on flats. They have a gravelly coarse sand substratum at a depth of 24 to 40 inches. The very poorly drained Parnell soils are in deep depressions. They have accumulated clay in the subsoil. The poorly drained Tonka soils are in shallow depressions. They have a leached subsurface layer and have accumulated clay in the subsoil.

Permeability is moderately slow in the Vallers soil, and runoff is very slow. A seasonal high water table is between the surface and a depth of 1 foot. Available water capacity is moderate. Organic matter content is high. Tilth is good. Salts reduce the amount of water available to plants.

Most areas are used for cultivated crops, hay, or pasture. This soil is best suited to hay, pasture, range, and wildlife habitat. It is poorly suited to cultivated crops because of wetness and the salinity. The main concern in managing cultivated areas is overcoming the salinity and the wetness. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. In undrained areas the wetness delays or prevents tillage and seeding in some years. Fallowing should be avoided because it can result in salt accumulation in the surface layer. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on this soil are western wheatgrass, inland saltgrass, and Nuttall alkaligrass. Alkali sacaton and sweetclover are suitable hay and pasture plants. The high salt content, soil blowing, and the limited amount of available water in the soil are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the salt-tolerant plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the reduced amount of available

water resulting from the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare soil surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect seedlings from abrasion.

This soil generally is unsuited to buildings and septic tank absorption fields because of the wetness. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat ranges from 22 to 42, depending on the degree of drainage. The range site is Saline Lowland.

80—Marysland loam. This deep, level, poorly drained, highly calcareous soil is on flats and in swales on outwash plains. It is subject to flooding. Individual areas range from 5 to 70 acres in size.

Typically, the surface soil is black loam about 18 inches thick. The subsoil is very dark gray, mottled loam about 6 inches thick. The next layer is very dark brown loam about 6 inches thick. The upper part of the substratum is grayish brown, mottled loam. The lower part to a depth of about 60 inches is dark grayish brown gravelly coarse sand.

Included with this soil in mapping are small areas of Colvin, Divide, and Vallers soils. These soils make up about 25 percent of the unit. The poorly drained Colvin soils have a silty clay loam surface layer and subsoil. The somewhat poorly drained Divide soils are on rises. They have an olive brown substratum. The poorly drained Vallers soils have a loam substratum. Colvin and Vallers soils occur as areas intermingled with areas of the Marysland soil.

Permeability is moderate in the upper part of the Marysland soil and rapid in the lower part. Runoff is slow. A seasonal high water table is at a depth of 1.0 foot to 2.5 feet. Available water capacity is moderate. Organic matter content is high. Tilth is good.

Most areas are used for pasture or hay. If drained, this soil is suited to small grain, flax, and sunflowers. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. In undrained areas the wetness frequently delays and sometimes prevents tillage, seeding, or harvesting. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on this soil are big bluestem and switchgrass. Creeping foxtail, big bluestem, and alsike clover are suitable hay and pasture plants. No major problems affect the use of this soil for range or pasture.

Drained areas of this soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to buildings and septic tank absorption fields because of the wetness and the flooding. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 35 to 62, depending on the degree of drainage. The range site is Subirrigated.

81B—Edgeley loam, 2 to 6 percent slopes. This moderately deep, nearly level and gently sloping, well drained soil is on rises on till plains. Individual areas range from about 20 to 60 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is about 24 inches thick. It is very dark grayish brown loam in the upper part, dark grayish brown clay loam in the next part, and very dark grayish brown channery silty clay loam in the lower part. Below this is shale bedrock.

Included with this soil in mapping are small areas of Cavour, Fordville, and Svea soils. Also included are some areas of moderately sloping soils. Included soils make up about 25 percent of the unit. The moderately well drained Cavour soils are in swales. They have an alkali subsoil. The well drained Fordville soils have a gravel and sand substratum. They occur as areas intermingled with areas of the Edgeley soils. The moderately well drained Svea soils are in swales. They have a loam substratum.

Permeability is moderate in the Edgeley soil, and runoff is medium. Available water capacity is low. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, corn, and sunflowers. The main concern in managing cultivated areas is controlling

water erosion. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. A system of conservation tillage that leaves crop residue on the surface and grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important range plants on this soil are western wheatgrass, green needlegrass, little bluestem, and porcupinegrass. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control water erosion.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating the grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings.

This soil is suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The depth to bedrock is a limitation on sites for septic tank absorption fields. A mound system helps to overcome this limitation.

The land capability classification is IIe. The productivity index for spring wheat is 67. The range site is Silty.

82—Sinai silty clay loam, 0 to 2 percent slopes. This deep, level, well drained soil is on foot slopes in stream valleys. Individual areas range from 20 to 200 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil is about 34 inches thick. In sequence downward, it is black silty clay loam, very dark grayish brown silty clay, dark grayish brown silty clay, and olive gray silty clay. The next layer is olive gray, mottled silty clay about 6 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled silty clay. In places the surface layer is silty clay.

Included with this soil in mapping are small areas of LaDelle and Nutley soils. These soils make up about 20 percent of the unit. The moderately well drained LaDelle soils are in drainageways. They have a silty clay loam subsoil and substratum. The well drained Nutley soils are on side slopes. They have a dark surface layer that extends to a depth of only 7 to 16 inches.

Permeability is slow in the Sinai soil. Runoff also is slow. Available water capacity and organic matter content are high. Tilth is fair.

Most areas are used for cultivated crops. This soil is well suited to sunflowers, corn, and small grain. The main concerns in managing cultivated areas are maintaining or improving tilth and controlling water erosion in areas where runoff concentrates. The hazards of soil blowing and water erosion are slight. Tillage when the soil is neither too wet nor too dry helps to prevent surface compaction and to maintain or improve tilth. Returning crop residue to the soil also helps to improve tilth. A system of conservation tillage and grassed waterways in areas where runoff concentrates help to control water erosion.

The important range plants on this soil are western wheatgrass, green needlegrass, and blue grama. Smooth bromegrass, Russian wildrye, green needlegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of this soil for range or pasture.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings.

This soil is suited to buildings, but it is poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The slow permeability is a limitation on sites for septic tank absorption fields. A mound system helps to overcome this limitation.

The land capability classification is IIc. The productivity index for spring wheat is 89. The range site is Clayey.

82B—Sinai silty clay loam, 2 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on foot slopes in stream valleys. Individual areas range from about 20 to 150 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil is about 34 inches thick. In sequence downward, it is black silty clay loam, very dark grayish brown silty clay, dark grayish brown silty clay, and olive gray silty clay. The next layer is

olive gray, mottled silty clay about 6 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled silty clay. In places the surface layer is silty clay.

Included with this soil in mapping are small areas of the well drained Nutley soils on side slopes. Nutley soils have a dark surface layer that extends to a depth of only 8 to 16 inches. Also included are small areas of soils that have shale bedrock within a depth of 30 to 60 inches. Included soils make up about 20 percent of the unit.

Permeability is slow in the Sinai soil, and runoff is medium. Available water capacity and organic matter content are high. Tilth is fair.

Most areas are used for cultivated crops. This soil is well suited to sunflowers, corn, and small grain. The main concerns in managing cultivated areas are controlling water erosion and maintaining tilth. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Tillage when the soil is neither too wet nor too dry helps to prevent surface compaction and to maintain or improve tilth. Returning crop residue to the soil also helps to improve tilth. A system of conservation tillage, diversions, terraces, and grassed waterways in areas where runoff concentrates help to control water erosion.

The important range plants on this soil are western wheatgrass, green needlegrass, and blue grama. Smooth bromegrass, Russian wildrye, green needlegrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control water erosion.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings.

This soil is suited to buildings, but it is poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The slow permeability is a limitation on sites for septic tank absorption fields. A mound system helps to overcome this limitation.

The land capability classification is IIe. The productivity index for spring wheat is 79. The range site is Clayey.

83F—Kloten-Buse complex, 9 to 35 percent slopes. These strongly sloping to steep, well drained soils are in stream valleys. The shallow Kloten soil is on the lower side slopes. The deep Buse soil is on shoulder slopes, the upper side slopes, and summits. These soils are subject to slumping and soil creep. Individual areas range from 40 to 2,000 acres in size. They are 50 to 65 percent Kloten silty clay loam and 25 to 35 percent Buse loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Kloten soil has a very dark grayish brown silty clay loam surface layer about 5 inches thick. The next layer is dark grayish brown silty clay loam about 5 inches thick. The substratum to a depth of about 16 inches is dark gray very channery silty clay loam. Below this is shale bedrock.

Typically, the Buse soil has a black loam surface layer about 6 inches thick. The subsoil is loam about 25 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The next layer is grayish brown, mottled loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled loam. In places the surface layer is eroded and is dark grayish brown.

Included with these soils in mapping are small areas of Barnes, Lamoure, Nutley, Sinai, and Sioux soils. Also included are a few small areas that have shale bedrock at a depth of 5 to 10 inches and a few small areas that have shale bedrock at a depth of 24 to 40 inches. Included areas make up about 25 percent of the unit. Barnes soils have a very dark grayish brown, noncalcareous subsoil. They are on the upper side slopes. Lamoure soils are poorly drained and are in drainageways. Nutley soils have a silty clay surface layer and substratum. They are on foot slopes. The well drained Sinai soils are on toe slopes. They have a silty clay surface layer and substratum. The excessively drained Sioux soils are on terraces. They have a gravelly substratum.

Permeability is moderate in the Kloten soil and moderately slow in the Buse soil. Runoff is very rapid on both soils. Available water capacity is very low in the Kloten soil and high in the Buse soil. Organic matter content is high in the Kloten soil and moderately low in the Buse soil.

Most areas are used for pasture, range, or wildlife habitat. These soils are best suited to range and wildlife habitat. They generally are unsuited to cultivated crops and pasture because of the very severe hazard of water erosion and the slope.

The important range plants on these soils are

needleandthread, little bluestem, western wheatgrass, and prairie sandreed. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Maintaining an adequate cover of the important plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

These soils generally are unsuited to buildings and septic tank absorption fields because of the steep and unstable slopes. Better sites generally are nearby.

The land capability classification of both soils is VIIe. The productivity index of the unit for spring wheat is 0. The range site of the Kloten soil is Shallow, and that of the Buse soil is Thin Upland.

84—Easby loam. This deep, level, poorly drained, highly calcareous, strongly saline soil is on flats on till plains. In some areas the surface is barren and has a salt crust. Individual areas range from about 10 to 300 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The lower part contains salt crystals. The next layer is dark gray loam about 8 inches thick. It also contains salt crystals. The subsoil is dark grayish brown, mottled loam about 6 inches thick. The next layer is grayish brown, mottled loam about 10 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Included with this soil in mapping are small areas of Vallers and Exline soils. These soils make up about 15 percent of the unit. The poorly drained Vallers soils are moderately saline. They occur as areas intermingled with areas of the Easby soil. The somewhat poorly drained Exline soils are on rises. They have an alkali subsoil.

Permeability is moderately slow in the Easby soil, and runoff is slow. A seasonal high water table is between the surface and a depth of 1 foot. Available water capacity is low. Organic matter content is high. Salts reduce the amount of water available to plants.

Most areas are used for range. This soil is suited to range and wildlife habitat. It generally is unsuited to cultivated crops, hay, and pasture because of wetness and the salinity.

The important range plants on this soil are western wheatgrass, inland saltgrass, and Nuttall alkaligrass. The high salt content, soil blowing, and the limited amount of available water in the soil are hazards, especially if the range is overgrazed. Maintaining an adequate cover of salt-tolerant plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

This soil is generally unsuited to buildings and septic tank absorption fields because of the wetness. Better sites generally are nearby.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Saline Lowland.

85—Exline silty clay loam. This deep, level, somewhat poorly drained, alkali soil is on flats on lake plains. Individual areas range from 5 to 100 acres in size.

Typically, the surface layer is black silty clay loam about 5 inches thick. The dense subsoil is about 31 inches thick. It is very dark grayish brown silty clay in the upper part, dark grayish brown silty clay in the next part, and grayish brown silty clay loam in the lower part. The next layer is grayish brown silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam. In places the soil has a silty clay surface layer and substratum.

Included with this soil in mapping are small areas of Nahon and Overly soils. These soils make up about 20 percent of the unit. The moderately well drained Nahon soils do not have salts within a depth of 16 inches. They occur as areas intermingled with areas of the Exline soil. The moderately well drained Overly soils are on rises. They have a nonalkali subsoil.

Permeability is very slow in the Exline soil, and runoff is slow. A seasonal high water table is at a depth of 2.5 to 4.0 feet. Available water capacity and organic matter content are moderate. Salts reduce the amount of water available to plants. The dense, alkali subsoil restricts the depth to which roots can penetrate.

Most areas are used for pasture, range, or wildlife habitat. This soil is best suited to range and pasture. It generally is unsuited to cultivated crops because of the dense subsoil, the alkalinity, droughtiness, and poor tilth.

The important range plants on this soil are western

wheatgrass and blue grama. Western wheatgrass, slender wheatgrass, and crested wheatgrass are suitable hay and pasture plants. The dense, alkali subsoil that restricts penetration of roots and the salts that reduce the amount of water available to plants are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important plants or of other suitable plants helps to prevent denuding. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

This soil is poorly suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to overcome the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements. The very slow permeability and the seasonal high water table are limitations on sites for septic tank absorption fields. A mound system helps to overcome these limitations.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Thin Claypan.

86—Overly-Nahon silt loams. These deep, level, moderately well drained soils are on lake plains. The Overly soil is on slight rises. The alkali Nahon soil is in shallow swales. Individual areas range from 5 to 100 acres in size. They are 45 to 60 percent Overly silt loam and 25 to 40 percent Nahon silt loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Overly soil has a black silt loam surface layer about 8 inches thick. The subsoil is silty clay loam about 29 inches thick. It is black in the upper part, dark grayish brown in the next part, and grayish brown in the lower part. The upper part of the substratum is light olive brown, mottled silty clay loam. The lower part to a depth of about 60 inches is light brownish gray, mottled very fine sandy loam. In places the soil contains more silt and less clay.

Typically, the Nahon soil has a black silt loam surface layer about 7 inches thick. The subsoil is about 31 inches thick. In sequence downward, it is very dark gray, dense silty clay loam; very dark grayish brown, dense silty clay; dark grayish brown silty clay loam with masses of salt; and light olive brown, mottled silty clay loam. The upper part of the substratum is light olive brown, mottled very fine sandy loam. The lower part to a depth of about 60 inches is light olive brown, stratified very fine sandy loam and silt loam.

Included with these soils in mapping are small areas of Bearden soils. Also included are some moderately well drained soils that have salts at a depth of 26 to 38 inches. They are intermingled with areas of the Nahon soil. Included soils make up about 15 percent of the unit. The somewhat poorly drained Bearden soils are in swales. They are saline and highly calcareous.

Permeability is moderately slow in the Overly soil and very slow in the Nahon soil. Runoff is slow on both soils. Available water capacity is high in the Overly soil and moderate in the Nahon soil. A seasonal high water table is at a depth of 4 to 6 feet in both soils. Organic matter content is high in the Overly soil and moderate in the Nahon soil. Tilth is fair. The dense, alkali subsoil in the Nahon soil restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, and alfalfa. The main concern in managing cultivated areas is improving root penetration in the dense, alkali subsoil of the Nahon soil. Crops growing on the Nahon soil have a characteristic stunted appearance because of moisture stress. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing alfalfa and managing crop residue help to increase the infiltration rate, improve or maintain tilth, and improve root penetration in the dense, alkali subsoil of the Nahon soil.

The important range plants on these soils are western wheatgrass, needleandthread, green needlegrass, and blue grama. Intermediate and pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for range or pasture.

The Overly soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. The Nahon soil is suited to only

a few of the drought- and salt-tolerant trees and shrubs. Irrigation helps to ensure the survival of seedlings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and by the reduced amount of available water caused by the salts in the Nahon soil.

These soils are suited to buildings, but they are poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements. The slow permeability and the seasonal high water table are limitations on sites for septic tank absorption fields. A mound system helps to overcome these limitations.

The land capability classification of the Overly soil is IIc, and that of the Nahon soil is IVs. The productivity index of the unit for spring wheat is 79. The range site of the Overly soil is Silty, and that of the Nahon soil is Claypan.

87—Svea-Cavour loams, 0 to 3 percent slopes. These deep, level and nearly level, moderately well drained soils are on till plains. The Svea soil is on rises. The alkali Cavour soil is in swales. Individual areas range from 5 to 100 acres in size. They are 45 to 60 percent Svea loam and 25 to 40 percent Cavour loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used. In a few areas southwest of Valley City, the Cavour soil makes up more than 40 percent of the unit.

Typically, the Svea soil has a black loam surface soil about 12 inches thick. The subsoil is loam about 31 inches thick. In sequence downward, it is very dark brown, very dark grayish brown, grayish brown, and light brownish gray and mottled. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the dark color of the surface soil extends to a depth of only 10 to 16 inches.

Typically, the Cavour soil has a black loam surface layer about 6 inches thick. The subsurface layer is very dark gray loam about 3 inches thick. The subsoil is about 29 inches thick. In sequence downward, it is black, dense clay loam; dark gray clay loam; olive gray loam; and olive, mottled loam. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the subsurface layer has been mixed with the surface layer by cultivation.

Included with these soils in mapping are small areas of Hamerly and Vallers soils and some stony areas. Also included are areas of some other moderately well drained soils that have salts at a depth of about 26 to 40 inches. They are intermingled with areas of the Cavour soil. Included areas make up about 15 percent of the unit. The somewhat poorly drained Hamerly soils are in swales. They are highly calcareous. The poorly drained Vallers soils are on flats and in swales. They are highly calcareous and are saline.

Permeability is moderately slow in the Svea soil and slow in the Cavour soil. Runoff is slow on both soils. Available water capacity is high in the Svea soil and moderate in the Cavour soil. A seasonal high water table is at a depth of 4 to 6 feet in both soils. Organic matter content is high in the Svea soil and moderate in the Cavour soil. Tilth is fair in both soils. The dense, alkali subsoil in the Cavour soil restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, and alfalfa. The main concern in managing cultivated areas is improving root penetration in the dense, alkali subsoil of the Cavour soil. Crops growing on the Cavour soil have a characteristic stunted appearance because of moisture stress. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing alfalfa and managing crop residue help to increase the infiltration rate, improve or maintain tilth, and improve root penetration in the dense, alkali subsoil of the Cavour soil.

The important range plants on these soils are western wheatgrass, needleandthread, green needlegrass, and big bluestem. Intermediate and pubescent wheatgrass, big bluestem, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for range or pasture.

The Svea soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. The Cavour soil is suited to only a few of the drought- and salt-tolerant species. Irrigation helps to ensure the survival of seedlings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the restricted root development in

the dense, alkali subsoil and by the reduced amount of available water caused by the salts in the soil.

These soils are suited to buildings, but they are poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements. The slow permeability and the seasonal high water table are limitations on sites for septic tank absorption fields. A mound system helps to overcome these limitations.

The land capability classification of the Svea soil is IIc, and that of the Cavour soil is IVs. The productivity index of the unit for spring wheat is 77. The range site of the Svea soil is Overflow, and that of the Cavour soil is Claypan.

88—Manfred and Vallers soils, extremely stony. These deep, level, extremely stony soils are in outwash channels. Stones cover about 20 to 40 percent of the surface. Any one area can consist of all Manfred soil, all Vallers soil, or a combination of both soils. In areas where the two soils occur together, the very poorly drained, alkali Manfred silt loam is in shallow depressions and the poorly drained, highly calcareous Vallers loam is on the lower rises. Individual areas range from 5 to 200 acres in size.

Typically, the Manfred soil has a black silt loam surface layer about 5 inches thick. The subsoil is about 31 inches thick. It is black silty clay loam in the upper part; olive gray, mottled silty clay loam in the next part; and olive gray, mottled clay loam in the lower part. The upper part of the substratum is light olive gray, mottled clay loam. The lower part to a depth of about 60 inches is olive gray, mottled loam.

Typically, the Vallers soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 25 inches thick. It is dark gray in the upper part, light olive gray in the next part, and olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is dark gray, mottled loam. In some places the surface layer is silt loam, clay loam, or silty clay loam. In other places salt crystals are in the surface layer.

Included with these soils in mapping are small areas of Cavour, Easby, Exline, and Hamerly soils. These included soils make up about 15 percent of the unit. Cavour soils are moderately well drained and are on rises. Easby and Hamerly soils occur as areas intermingled with areas of the Vallers soil. The poorly drained Easby soils are highly calcareous and strongly saline. The somewhat poorly drained Hamerly soils have a light olive brown substratum. The somewhat poorly drained Exline soils have a silty clay subsoil. They occur as areas intermingled with areas of the Manfred soils.

Permeability is slow in the Manfred soil and moderately slow in the Vallers soil. Runoff is ponded on the Manfred soil and very slow on the Vallers soil. Available water capacity is moderate in the Manfred soil and high in the Vallers soil. A seasonal high water table is 1 foot above the surface to 1 foot below in the Manfred soil and at a depth of 1.0 foot to 2.5 feet in the Vallers soil. Organic matter content is high in both soils. The dense, alkali subsoil in the Manfred soil restricts the depth to which roots can penetrate.

Most areas are used for range or wildlife habitat. These soils are best suited to range. They generally are unsuited to cultivated crops and to trees and shrubs because of the stoniness and the alkalinity. The important range plants on these soils are western wheatgrass, alkali cordgrass, switchgrass, and big bluestem. The dense, alkali subsoil that restricts the penetration of roots and the salts that reduce the amount of water available to plants are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important plants helps to prevent denuding. Stock water ponds constructed in areas of the Manfred soil frequently contain salty water.

These soils generally are unsuited to buildings and septic tank absorption fields because of the wetness and the ponding. Better sites generally are nearby.

The land capability classification of both soils is VIs. The productivity index of the unit for spring wheat is 0. The range site of the Manfred soil is Saline Lowland, and that of the Vallers soil is Subirrigated.

89—Fordville loam, 0 to 3 percent slopes. This deep, level and nearly level, well drained soil is on flats on outwash plains and terraces. Individual areas range from 10 to 200 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 26 inches thick. It is very dark grayish brown in the upper part and light brownish gray in the lower part. The upper part of the substratum is dark grayish brown sand. The next part is dark brown very gravelly sand. The lower part to a depth of about 60 inches is very dark grayish brown gravelly sand. In the Stoney Slough drainage area, the gravel in the substratum is more than 35 percent shale fragments. In places the dark color of the surface layer extends to a depth of only 8 to 16 inches. In some

areas the soil is moderately well drained and has mottles at a depth of 30 to 40 inches. In other areas the depth to sand and gravel is only 14 to 20 inches.

Included with this soil in mapping are small areas of Divide, Gardena, and Glyndon soils. These soils make up about 15 percent of the unit. The somewhat poorly drained Divide and Glyndon soils are in swales. They are highly calcareous. The moderately well drained Gardena soils have a silt loam and very fine sandy loam substratum. They occur as areas intermingled with areas of the Fordville soil.

Permeability is moderate in the upper part of the Fordville soil and rapid in the lower part. Runoff is slow. Available water capacity is moderate. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. It is particularly well suited to rye and winter wheat, which make the best use of the early season moisture supply and help to control soil blowing in fall, winter, and spring. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. The hazards of soil blowing and water erosion are slight; however, soil blowing does occur during some windstorms. A system of conservation tillage that leaves crop residue on the surface, annual buffer strips, field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome the droughtiness. The stubble traps snow and thus increases the moisture supply. Because of the low available water capacity, fallowing is of limited value. Also, it increases the hazard of soil blowing.

The important range plants on this soil are needleandthread and western wheatgrass. Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of this soil for pasture or range.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is somewhat droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure the survival of seedlings. Little benefit is derived from fallowing in the season prior to planting because of the moderate available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is well suited to buildings, but it is poorly suited to septic tank absorption fields. Because of the rapid permeability, the soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIs. The productivity index for spring wheat is 63. The range site is Silty.

90—Dovray silty clay. This deep, level, very poorly drained soil is in depressions on lake plains. It is subject to ponding. Individual areas range from about 5 to 80 acres in size.

Typically, the surface layer is black silty clay about 8 inches thick. The next layer is black silty clay about 12 inches thick. The subsoil is silty clay about 25 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The substratum to a depth of about 60 inches is gray, mottled silty clay. It is calcareous at a depth of about 50 inches. In places the subsoil is calcareous.

Included with this soil in mapping are small areas of the poorly drained Fargo soils on rises. Also included are areas of poorly drained, highly calcareous soils on the rims of depressions. Included soils make up about 15 percent of the unit.

Permeability is very slow in the Dovray soil, and runoff is ponded. A seasonal high water table is 2 feet above the surface to 1 foot below. Available water capacity and organic matter content are high. Tilth is poor.

Most areas are used for cultivated crops. If drained, this soil is suited to small grain, corn, and sunflowers. A system of constructed drains removes surface water from most areas and increases the suitability for crops. In undrained areas the wetness generally delays or prevents seeding, tilling, and harvesting of cultivated crops. The main concerns in managing cultivated areas are improving or maintaining tilth and workability and maintaining drainage channels. Tillage when the soil is neither too wet nor too dry helps to prevent surface compaction and improves tilth. Plowing in the fall leaves the soil in good condition for seedbed preparation in the spring, but it increases the hazard of soil blowing. The hazard of soil blowing is moderate. Buffer strips and conservation tillage that leaves crop residue on the surface help to control soil blowing.

The important range plants on this soil are slough sedge and rivergrass. In drained areas reed canarygrass and creeping foxtail are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred when the soil is wet.

Drained areas of this soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to buildings and septic tank absorption fields because of the ponding and the very slow permeability. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 32 to 73, depending on the degree of drainage. The range site is Wetland.

91—Arveson loam. This deep, level, poorly drained soil is on flats on outwash plains. Individual areas range from about 10 to 80 acres in size.

Typically, the surface layer is very dark gray loam about 6 inches thick. The next 9 inches is also very dark gray loam. The subsoil is about 21 inches thick. It is light brownish gray, mottled loam in the upper part and dark grayish brown, mottled fine sandy loam in the lower part. The upper part of the substratum is grayish brown, mottled loamy fine sand. The lower part to a depth of 60 inches is gray, mottled clay loam.

Included with these soils in mapping are small areas of Marysland, Southam, and Vallers soils. Also included are small areas of somewhat poorly drained soils on rises. Included soils make up about 25 percent of the unit. The poorly drained Marysland and Vallers soils occur as areas intermingled with areas of the Arveson soil. Marysland soils are gravelly coarse sand in the lower part of the substratum. Vallers soils have a loam subsoil. The very poorly drained Southam soils are in deep depressions. They have a silty clay loam surface layer. They are silty clay in the upper part of the substratum.

Permeability is moderate in the upper part of the Arveson soil and rapid in the lower part. Runoff is slow. A seasonal high water table is between the surface layer and a depth of 2 feet. Available water capacity is moderate. Organic matter content is high. Tilth is good.

Most areas are used for pasture, hay, or wildlife habitat; however, some areas are used for cultivated crops. If drained, this soil is suited to small grain, alfalfa, corn, and sunflowers. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. The main concerns in managing cultivated areas are overcoming wetness and controlling soil blowing. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help to control soil blowing.

The important range plants on this soil are big bluestem and switchgrass. Reed canarygrass, big bluestem, creeping foxtail, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control soil blowing.

Drained areas of this soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover can improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to buildings and septic tank absorption fields because of the wetness. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 30 to 60, depending on the degree of drainage. The range site is Subirrigated.

92B—Barnes-Cavour loams, 3 to 6 percent slopes. These deep, gently sloping soils are on till plains. The well drained Barnes soil is on rises. The moderately well drained, alkali Cavour soil is in swales. Individual areas range from 5 to 100 acres in size. They are 45 to 60 percent Barnes loam and 15 to 30 percent Cavour loam. The two soils occur as areas so intricately mixed

or so small that mapping them separately is not practical at the scale used.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 22 inches thick. In sequence downward, it is very dark grayish brown, dark brown, dark grayish brown, and grayish brown. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the surface layer is eroded and is very dark grayish brown.

Typically, the Cavour soil has a black loam surface layer about 6 inches thick. The subsurface layer is very dark gray loam about 3 inches thick. The subsoil is about 29 inches thick. In sequence downward, it is black, dense clay loam; dark gray clay loam; olive gray loam; and olive, mottled loam. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the subsurface layer has been mixed with the surface layer by cultivation.

Included with these soils in mapping are small areas of Buse, Exline, and Hamerly soils and a few areas of moderately sloping soils and a few stony areas. Also included are some moderately well drained soils that have salts at a depth of 26 to 40 inches. They occur as areas intermingled with areas of the Cavour soils. Included areas make up about 25 percent of the unit. The well drained Buse soils are on knolls and knobs. They have a subsoil that is calcareous throughout. The somewhat poorly drained Exline soils have salts at a depth of about 5 inches. They occur as areas intermingled with areas of the Cavour soil. The somewhat poorly drained Hamerly soils are in swales. They are highly calcareous.

Permeability is moderately slow in the Barnes soil and slow in the Cavour soil. Runoff is medium on both soils. Available water capacity is high in the Barnes soil and moderate in the Cavour soil. A seasonal high water table is at a depth of 4 to 6 feet in the Cavour soil. Organic matter content is high in the Barnes soil and moderate in the Cavour soil. Tilth is fair in both soils. The dense, alkali subsoil in the Cavour soil restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops. These soils are suited to small grain, sunflowers, and alfalfa. The main concerns in managing cultivated areas are improving root penetration in the dense, alkali subsoil of the Cavour soil and controlling water erosion. Crops growing on the Cavour soil have a characteristic stunted appearance because of moisture stress. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing alfalfa and managing crop residue help to increase the infiltration rate, improve or maintain tilth, and improve root penetration in the dense, alkali subsoil of the Cavour soil.

The important range plants on these soils are western wheatgrass, needleandthread, green needlegrass, and porcupinegrass. Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important plants or of other suitable plants helps to control water erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover can improve the survival and growth rates of the seedlings. The Cavour soil is suited to only a few of the drought- and salt-tolerant species. Irrigation helps to ensure the survival of the seedlings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and by the reduced amount of available water caused by the salts in the soil.

These soils are suited to buildings. The Barnes soil is suited to septic tank absorption fields, but the Cavour soil is poorly suited. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements in areas of the Cavour soil. The moderately slow permeability of the Barnes soil is a limitation on sites for septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table and the slow permeability of the Cavour soil are limitations on sites for absorption fields. A mound system helps to overcome these limitations.

The land capability classification of the Barnes soil is IIe, and that of the Cavour soil is IVs. The productivity index of the unit for spring wheat is 64. The range site of the Barnes soil is Silty, and that of the Cavour soil is Claypan.

98B—Barnes-Svea loams, 0 to 6 percent slopes, extremely stony. These deep, level to gently sloping, extremely stony soils are on till plains. The well drained Barnes soil is on rises. The moderately well drained Svea soil is in swales. Stones cover about 20 to 40 percent of the surface, and they make up about 20 to 30 percent of the volume in the soil profile. Individual areas range from 5 to 50 acres in size. They are 55 to 75 percent Barnes loam and 20 to 40 percent Svea loam. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical at the scale used.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 22 inches thick. In sequence downward, it is very dark grayish brown, dark brown, dark grayish brown, and grayish brown. The substratum to a depth of about 60 inches is light olive brown loam. In a few places the surface layer is silt loam or gravelly loam.

Typically, the Svea soil has a black loam surface soil about 12 inches thick. The subsoil is loam about 31 inches thick. In sequence downward, it is very dark brown, very dark grayish brown, grayish brown, and light brownish gray and mottled. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Included with these soils in mapping are small areas of Buse and Hamerly soils. These included soils make up about 5 percent of the unit. The well drained Buse soils are on knobs. They have a subsoil that is calcareous throughout. The somewhat poorly drained Hamerly soils are on flats. They are highly calcareous.

Permeability is moderately slow in the Barnes and Svea soils. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Organic matter content is high in both soils.

Most areas are used for range. These soils generally are unsuited to cultivated crops, pasture, trees, and shrubs because of the stoniness. They are best suited to range. No major hazards affect the use of these soils for range. The important range plants on these soils are western wheatgrass, needleandthread, and green needlegrass.

These soils generally are not used as sites for septic tank absorption fields and buildings because of the size and number of stones. Better sites generally are nearby.

The land capability classification of both soils is VIIs. The productivity index of the unit for spring wheat is 0. The range site of both soils is Silty.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 639,060 acres in Barnes County, or nearly 67 percent of the total acreage, meets the soil requirements for prime farmland. Nearly all of this prime farmland is used for crops. The principal crops grown on this land are wheat, barley, corn, and sunflowers.

The map units in the survey area that are considered prime farmland are listed at the end of this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need

for these measures is indicated after the map unit name. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

The map units that meet the requirements for prime farmland are:

2	Tonka silt loam (where drained)
9	Nutley silty clay, 0 to 2 percent slopes
9B	Nutley silty clay, 2 to 6 percent slopes
12	Lismore-Kranzburg silty clay loams, 0 to 2 percent slopes
13B	Kranzburg-Lismore silty clay loams, 2 to 6 percent slopes
14B	Barnes-Buse loams, 3 to 6 percent slopes
15	Swenoda-Lanona fine sandy loams, 0 to 2 percent slopes
15B	Lanona-Swenoda fine sandy loams, 2 to 6 percent slopes
17B	Barnes-Svea loams, 2 to 6 percent slopes
18	Bearden silty clay loam
26	Colvin silty clay loam (where drained)
27	Divide loam
31B	Egeland fine sandy loam, 1 to 6 percent slopes
36	Fargo silty clay (where drained)
40B	Gardena-Zell silt loams, 3 to 6 percent slopes
43	Gardena silt loam
46	Gardena-Glyndon silt loams, 0 to 3 percent slopes
48	Glyndon silt loam
50	Hamerly-Tonka complex, 0 to 3 percent slopes (where drained)
56	LaDelle silty clay loam
62	Overly-Bearden silty clay loams
65	Svea-Barnes loams, 0 to 2 percent slopes
66	Hamerly-Wyard loams, 0 to 3 percent slopes (where drained)
66B	Hamerly loam, 3 to 6 percent slopes
80	Marysland loam (where drained)
81B	Edgeley loam, 2 to 6 percent slopes
82	Sinai silty clay loam, 0 to 2 percent slopes
82B	Sinai silty clay loam, 2 to 6 percent slopes
89	Fordville loam, 0 to 3 percent slopes
91	Arveson loam (where drained)

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Lyle Samson, agronomist, and Jerome P. Timm, soil conservationist, Soil Conservation Service, helped to prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 88 percent of Barnes County is cultivated. The 1984 figures show 432,900 acres used for close-grown crops, 161,500 acres for row crops, and 36,000 acres for forage crops *(13)*. The acreage of summer fallow was 74,000 in 1980, 55,000 in 1981, 80,000 in 1982, 190,000 in 1983, and 120,000 in 1984. The acreage used for sunflower production has fluctuated, but it generally is declining. It averaged 150,400 acres per year from 1980 to 1984. It was 155,000 acres in 1980 and 135,000 acres in 1984. The acreage used for corn and forage has been relatively stable since 1980.

In 1984 the acreages of the principal close-grown crops were as follows: spring wheat, 200,000 acres; durum wheat, 28,000 acres; winter wheat, 48,500 acres; barley, 140,000 acres; oats, 14,000 acres; and flax, 14,000 acres. The main row crops were sunflowers and corn. Sunflowers were grown on 135,000 acres, corn for grain on 20,900 acres, and corn for silage on 5,600

acres. Alfalfa was grown on 16,000 acres and other hay crops on 20,000 acres. Small acreages were planted to mustard, rye, buckwheat, lentils, millet, and soybeans.

The potential of the soils in Barnes County for increased production of food and fiber is good. This production is steadily increasing as the latest crop production technology is applied. This soil survey can facilitate the application of this technology.

The soils and climate of the county are suited to most of the crops that are commonly grown in the survey area. Crops that are not commonly grown but are suitable include dry edible beans, potatoes, and rapeseed.

The principal management measures that help to ensure continuing productivity are those that control soil blowing and water erosion, maintain or improve fertility and tilth, and result in proper use of soil moisture.

Water erosion and soil blowing reduce the productivity of the soils. If the surface layer is lost, most of the available plant nutrients also are lost. As a result, applications of fertilizer are needed to maintain adequate crop production.

Of equal concern is the loss of organic matter through erosion. Soil structure, water infiltration, available water capacity, and tilth are all negatively affected by this loss. As organic matter is lost and the subsoil is exposed and tilled, the remaining soil becomes increasingly susceptible to both soil blowing and water erosion.

Soil blowing is a hazard on most of the soils in Barnes County. It is a severe hazard on the coarse textured and moderately coarse textured soils, including those of the Egeland, Lanona, and Swenoda series.

Bearden, Buse, Colvin, Divide, Easby, Glyndon, Hamerly, Vallers, and other soils that have a relatively high content of lime are susceptible to soil blowing in spring if they have been bare throughout the winter. Because of freezing and thawing, soil structure breaks down, resulting in aggregates that are susceptible to movement. Nearly all soils can be damaged by soil blowing if they are bare.

Water erosion is a severe hazard on moderately sloping and steeper soils, such as Barnes, Buse, Kloten, Svea, and Zell (fig. 8). The hazard is greatest when the surface is bare.

Conservation practices that control both soil blowing and water erosion are those that maintain a protective cover on the surface. Examples are conservation tillage systems that keep a protective amount of crop residue on the surface. Applications of herbicides can help to eliminate the need for summer fallow tillage. Cover crops are also effective in controlling both soil blowing and water erosion. Field windbreaks, annual wind barriers, and stripcropping help to control soil blowing. Inclusion of grasses and legumes in the cropping system, grassed waterways, diversions, terraces, contour farming, and field stripcropping across the slope help to control water erosion. A management system that uses several measures is the best means of protecting the soil. For example, conservation tillage can control soil blowing during years when the amount of crop residue is adequate, but windbreaks are needed during years when the amount of residue is low.

Moisture at planting time is critical to success of the crop during the growing season. In years when the amount of available soil moisture is low at planting time, crop success for the year is greatly reduced. Measures that reduce evaporation and runoff rates, increase the rate of water infiltration, and control weeds also conserve moisture. Examples are: using stubble mulch tillage; no-till farming; stripcropping; growing cover crops; managing crop residue; letting stubble stand, which traps snow; and applying fertilizer. When fallow is used to conserve moisture for the next season, a cover of crop residue is essential during winter to guard against moisture loss and erosion. Weed control helps to prevent depletion of the soil moisture supply.

Measures that improve fertility are needed on many soils. Examples are: applying commercial fertilizer, growing green-manure crops, including legumes in the cropping system, and applying barnyard manure.

Proper management of soils includes measures that maintain good tilth. These measures are particularly needed on the Cavour and Nahon soils that have an alkali subsoil. They are also needed on the Bearden, Colvin, Dovray, Edgeley, Fargo, Kranzburg, LaDelle, Lismore, Nutley, Overly, and Sinai soils that have a silty clay loam or silty clay surface layer. Measures that maintain the content of organic matter are important if good tilth is to be maintained. The traditional practice of clean-tilled summer fallow contributes to the loss of organic matter because it increases susceptibility of the soils to erosion.

Management of Saline and Alkali Soils

Saline and alkali soils make up about 7 percent of Barnes County. Saline soils make up about 4 percent of the area, or about 42,780 acres; alkali soils make up about 2 percent, or about 23,510 acres; and saline-alkali soils make up about 1 percent, or about 3,470 acres.

Saline soils have a high concentration of soluble salts, or salts that dissolve in water. The saline soils in

Figure 8.—The severe hazard of water erosion results in sedimentation in an area of Barnes-Buse loams, 6 to 9 percent slopes.

Barnes County are in the the Colvin, Easby, Glyndon, and Vallers series.

Saline soils generally develop in areas of restricted drainage such as those adjacent to sloughs and waterways. Where drainage is poor, salts rise with the water table and are concentrated near the surface. This salt buildup is reduced by maintaining a surface cover of plants. The plant roots use the soil water before it can reach the surface and before the salts accumulate. The surface cover prevents evaporation at the surface, the upward movement of water in the soil, and the concentration of salts at the surface.

Plants growing on saline soils absorb salts from the soil water. Excess amounts of certain salts may interfere with plant growth. High concentrations of some salts are toxic to certain plants. Some salts cause nutritional imbalances or deficiencies by restricting the uptake or availability of certain plant nutrients. Detecting salinity by visual observations in the field is difficult. The salts generally are not visible during much of the growing season, particularly when the soil is moist. Flecks, threads, or masses of soluble salts are commonly visible when the soil is dry. Laboratory analysis is needed to determine the actual degree of salinity in soils.

Crop response, particularly during periods of soil moisture stress, is a useful indicator of the degree of salinity in saline soils. For instance, a small grain crop growing on saline soils tends to be stunted and has fewer tillers than small grain on nonsaline soils. Strongly saline soils are best suited to native grasses or to salt-tolerant introduced grasses. Slightly saline or moderately saline soils can produce salt-tolerant crops and forage. Barley is the most salt-tolerant of the small

grains. Of the forage crops, tall wheatgrass, western wheatgrass, and alfalfa are salt-tolerant once they are established.

Alkali soils are characterized by a high content of exchangeable sodium, which adheres to the clay particles in the soil. The alkali soils in Barnes County are those of the Cavour and Nahon series. Locally, alkali soils are known as "alkali," or "gumbo."

Alkali soils develop in a complex pattern with a very distinct microrelief. The physical and chemical properties of these soils differ markedly within very short distances. In many areas the distance between the alkali soils and the surrounding soils that have normal physical properties is only a few feet, perhaps 5 to 10 feet.

Alkali soils develop in areas of saline soils that contain large quantities of sodium salts. Over a long period, usually centuries, as the water table drops, rain gradually leaches the salts from the upper layers to the lower ones. During this leaching process, the clay in the soil becomes saturated with sodium, disperses, and moves downward with the percolating water. As the moving clay concentrates, a dense, alkali subsoil forms. The dense subsoil is hard when dry, sticky when wet, and nearly impervious to roots, water, and air. An example of soils that have a dense, alkali subsoil are those of the Cavour and Nahon series.

As the leaching by soil water continues, the sodium is gradually moved lower in the soil profile and eventually is carried below rooting depth. The result is a more manageable soil, such as Aberdeen. If the leaching process continues and nearly all of the sodium is removed from the profile, the soil eventually changes into a nonalkali soil. This change requires a long period, usually centuries *(4)*.

If plowed, alkali soils are characterized by a surface layer that is sticky when wet and hard and cloddy when dry. A crust forms easily at the surface. The chemical and physical properties of these soils are unfavorable for plant growth. The harmful effects of the properties on plants generally increase as the sodium content increases. The effects of the reduced amount of water available to plants are more harmful than the toxic effect of the sodium. The plants also are affected by the depth to the dense subsoil.

Identification of alkali soils in cultivated fields commonly is difficult because many of the physical characteristics, such as columnar structure, have been altered by tillage. Crop response, particularly during periods of soil moisture stress, is a useful indicator of the level of alkalinity in a soil. Crops grown on soils with varying amounts of sodium exhibit varying heights and stages of development. If the level of alkalinity is very high, the crop cannot grow. The effects of sodium on crop growth are influenced by weather conditions, the stage of crop growth, and the soil moisture status. A measure of the effect of alkalinity on vegetative growth is not necessarily a reliable measure of crop yields. In many areas the yields of barley and wheat are affected less than the vegetative growth of these crops.

The variability of alkali soils can cause management problems. The soils that have a dense, alkali subsoil near the surface, such as Cavour and Nahon soils, are better suited to grass than to small grain and sunflowers.

Timely tillage is an important management need in areas of alkali soils, such as Cavour. These areas should be tilled and seeded only when the moisture content is favorable. If worked when too wet, the soils puddle and crust. If the soils are tilled when too dry, tillage and seeding implements cannot easily penetrate them. Deep plowing and chemical amendments can help to reclaim alkali soils, but their use may not be feasible. To be effective, deep tillage should reach to the alkali subsoil and mix several inches of the underlying material with the subsoil and topsoil. Depending on the soil, tillage to a depth of 15 to 36 inches may be needed. Any reclamation of alkali soils is a long-term endeavor. Complete reclamation may never be achieved. Onsite investigation is needed to confirm the feasibility of deep tillage in a particular area.

Saline-alkali soils develop in areas of restricted drainage where salts rise with the water table but where some leaching downward of clay and some saturation with sodium are evident and a dense, alkali subsoil has formed. The saline-alkali soils in Barnes County are those of the Exline and Manfred series. The management needs and crop responses on these soils are a combination of those on saline soils and those on alkali soils.

Additional information about management or reclamation of saline and alkali soils is available from offices of the Soil Conservation Service, the North Dakota Agricultural Experiment Station, and the Cooperative Extension Service.

Productivity Index

The productivity index is a relative rating of the ability of a particular map unit to produce a particular crop yield in comparison with other map units. The index ranges from 0, which indicates no yield, to 100 which indicates the highest yield. When the index is calculated, the similar and contrasting inclusions are

considered, as well as the soils or soils specified in the name of the map unit.

In Barnes County, a productivity index of 100 was considered equal to an average yield of 40 bushels per acre of spring wheat. Multiplying the productivity index by 40 and then dividing the product by 100 will convert the index number to a figure representing the expected average yield per acre. Barnes-Buse loams, 3 to 6 percent slopes, for example, has a productivity index of 69, which when multiplied by 40 and then divided by 100, converts to 28, which is the expected annual yield of spring wheat in bushels per acre for this map unit (see table 5).

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management or as otherwise stated are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops *(18)*. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations or hazards that restrict their use.

Class II soils have moderate limitations or hazards that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations or hazards that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations or hazards that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations or hazards, impractical to remove, that limit their use.

Class VI soils have severe limitations or hazards that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations or hazards that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations or hazards that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant

growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Rangeland

This section was prepared by Roy S. Mann, range conservationist, Soil Conservation Service.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

The native vegetation on rangeland consists of a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. Generally, the plants are suitable for grazing and the plant cover is sufficiently productive to justify grazing. Cultural treatments generally are not used to increase forage production. The composition and production of the plant community are determined by soil, climate, topography, overstory canopy, and grazing management.

In 1985, approximately 35,000 acres in Barnes County, or about 4 percent of the total acreage, was rangeland. In areas where it is properly managed, this rangeland is similar to the presettlement prairie of the late 1800's and early 1900's. Most of the rangeland is on loamy glacial till plains and moraines and on loamy and silty valley side slopes and shoulder slopes. Much of it occurs as rolling to steep, well drained soils or level, poorly drained or very poorly drained soils. The soils are generally unsuited or, at best, poorly suited to cultivated crops.

In 1985, the farms and ranches in the county had about 31,000 head of cattle. Of that number, about 1,700 were milk cows *(5)*. Most of the ranches include a cow-calf operation. A number also include a yearling operation, which adds flexibility during periods of low or high forage production. On some ranches used for a cow-calf operation, sheep are raised for improved income stability.

Because of the relatively short growing season, many farmers and ranchers have established cool-season tame pastures to supplement the forage produced on rangeland and to extend the grazing season in spring and fall. Droughts of short duration are common. As a result, cool-season pastures cannot be grazed in fall in many years. Generally, large amounts of hay and feed are needed because of the long winters. Hay was harvested on about 36,000 acres in 1984 *(5)*.

Range Site and Condition Classes

Soils vary in their capacity to produce grasses and other plants suitable for grazing. Soils that produce about the same kinds and amounts of forage are grouped into a range site.

Each range site has a distinctive potential plant community that is referred to as the climax vegetation. The climax vegetation is relatively stable and indicates what the range site is capable of producing. It reproduces itself annually and changes very little as long as the environment remains unchanged. On the prairie the climax vegetation consists of the kinds of plants that grew when the region was settled. It is generally the most productive combination of forage plants that can be grown on the site. When the site is improperly grazed, some of the climax vegetation decreases in relative importance and some of it increases. Also, other plants invade the site.

Decreaser plants are the species that decline in quantity under close, continuous grazing. They generally are the tallest and most productive grasses and forbs and are the most palatable to livestock.

Increaser plants are the species that increase in quantity under close grazing at the expense of the decreaser species. They generally are the shorter plants or the ones less palatable to livestock.

Invader plants are species normally not included in the climax plant community because they cannot compete with the climax vegetation for moisture, nutrients, and light. They invade the site only after the extent of the climax vegetation has been reduced by heavy continual grazing. Most invader species have little grazing value.

Range condition classes indicate the present composition of the plant community on a range site in relation to the climax vegetation. Range condition is expressed as excellent, good, fair, or poor, depending on how much the present plant community has departed from the climax. *Excellent* indicates that 76 to 100 percent of the present plant community is the same as the climax vegetation; *good*, 51 to 75 percent; *fair*,

26 to 50 percent; and *poor*, 25 percent or less.

Potential forage production depends on the kind of range site. Current forage production depends on the range condition and the amount of moisture available to the plants during the growing season.

Table 6 shows, for nearly all of the soil in the county, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. Only those soils that are used as rangeland or are suited to use as rangeland are listed. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is considered as forage for grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, kinds of plants, amount of shade, recent rains, and unseasonable dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only, not necessarily a forage value rating.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of forage, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Good range management keeps the range in excellent or good condition. Water is conserved, yields are improved, and soils are protected. The main management concern is recognizing the changes in the plant community that take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall, for example, may lead to the conclusion that the range is in good condition, when actually the plant cover is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been grazed closely for a short period may have a degraded appearance that temporarily obscures its quality and ability to recover rapidly.

Rangeland can recover from prolonged overuse if the climax decreaser species have not been completely grazed out. If overgrazing is stopped, enough climax plants generally remain for proper grazing use, deferred grazing, and the grazing system to restore the rangeland to an excellent condition. In areas where the climax plant community has been destroyed, range seeding can improve the condition. Seeding the proper climax species also can restore productive rangeland in areas of poor-quality cropland. Brush control, development of watering facilities, and other mechanical practices are needed to improve the potential of some rangeland. Proper management is one of the most overlooked means of improving rangeland. Adequate fencing is essential to achieve proper management.

The following paragraphs describe the range sites in Barnes County. The names of these sites are Clayey, Claypan, Limy Subirrigated, Overflow, Saline Lowland, Sandy, Shallow, Shallow to Gravel, Silty, Subirrigated, Thin Claypan, Thin Upland, Very Shallow, Wetland, and Wet Meadow.

Clayey range site. This site is dominated by a mixture of cool-season, mid grasses and an understory of short grasses. The principal species are western wheatgrass, porcupinegrass, needleandthread, and green needlegrass. The understory plants are blue grama, prairie junegrass, Pennsylvania sedge, and

other upland sedges. Forbs, such as western yarrow, scarlet globemallow, and gray sagewort, make up about 5 percent of the total herbage. The common woody plants are fringed sagebrush, western snowberry, and prairie rose.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, porcupinegrass, needleandthread, green needlegrass, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, fringed sagebrush, and upland sedges. Further deterioration results in a dominance of blue grama, Kentucky bluegrass, upland sedges, western ragweed, and fringed sagewort.

Very few problems affect management of this site. The water infiltration rate is slow. As a result, an adequate cover of vegetation is needed to ensure that forage production is not reduced by runoff. Areas where the range is in fair condition can generally be restored to good or excellent condition by good management of the remnant climax species.

Claypan range site. The climax vegetation on this site is primarily a mixture of short and mid grasses, sedges, and forbs. The principal species are western wheatgrass, green needlegrass, needleandthread, and prairie junegrass. Other species are blue grama and upland sedges. The common forbs are scarlet globemallow, silver scurfpea, and rush skeletonplant. A common shrub is fringed sagebrush.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and western wheatgrass. The plants that increase in abundance under these conditions are inland saltgrass, blue grama, Sandberg bluegrass, upland sedges, and fringed sagebrush. Further deterioration results in a dominance of blue grama, inland saltgrass, upland sedges, fringed sagebrush, and unpalatable forbs.

This site is easily damaged by overgrazing. Because of a dense subsoil and the content of salts in the soil, reestablishing the vegetation is difficult in denuded areas. Careful management that maintains the abundance of the key plants helps to maintain forage production and protect the soil from water erosion.

Limy Subirrigated range site. Tall grasses dominate this site. The principal species are little bluestem, big bluestem, indiangrass, and switchgrass. Other species are slim sedge, fescue sedge, and Baltic rush. The common forbs are Maximilian sunflower, stiff sunflower, American licorice, and Missouri goldenrod. They make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, indiangrass, switchgrass, Maximilian sunflower, and stiff sunflower. Little bluestem initially increases in abundance under these conditions, but it eventually decreases. Further deterioration results in a dominance of Kentucky bluegrass, Baltic rush, common spikerush, and low-growing sedges, grasses, and forbs.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or a planned grazing system can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major grass species.

Overflow range site. Both tall and mid grasses are dominant when this site is in excellent condition. The principal species are big bluestem, green needlegrass, western wheatgrass, and needleandthread. Other species are porcupinegrass, switchgrass, fescue sedge, and little bluestem. Several forbs, such as Maximilian sunflower, soft goldenrod, gray sagewort, and heath aster, make up about 10 percent of the total herbage. Several woody plants, such as western snowberry, fringed sagebrush, and common chokecherry, commonly grow on the site, depending on the position on the landscape. They may make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, green needlegrass, prairie dropseed, and switchgrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, Pennsylvania sedge, fescue sedge, and Kentucky bluegrass. Further deterioration results in a dominance of blue grama, sedges, and unpalatable forbs.

Because of its position on the landscape, this site is frequently overgrazed. Separating this site by fencing generally is not feasible because of the small size or the shape of areas of this site. As a result of flooding and the runoff received by these areas, this is a very productive site when properly managed. A planned grazing system can restore the site and maintain a high level of productivity. Reseeding is needed in areas that have been farmed. In areas where shrubs dominate,

brush control with proper management can help to restore productivity.

Saline Lowland range site. Salt-tolerant, mid grasses dominate this site. The principal species are Nuttall alkaligrass, inland saltgrass, alkali cordgrass, and salt-tolerant species of western wheatgrass and slender wheatgrass. Other species are alkali muhly, plains bluegrass, foxtail barley, and prairie bulrush. Forbs, such as western dock, silverweed cinquefoil, and Pursh seepweed, make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as Nuttall alkaligrass, slender wheatgrass, western wheatgrass, and alkali cordgrass. The plants that increase in abundance under these conditions are inland saltgrass, alkali muhly, foxtail barley, and mat muhly. Further deterioration results in a dominance of inland saltgrass, foxtail barley, silverweed cinquefoil, and western dock.

A high content of salts and a restricted available water capacity limit forage production on this site. Careful management of the adapted salt-tolerant plants can maintain good forage production. If the plant community has been severely damaged, however, the site recovers slowly. Soil blowing and water erosion are hazards in denuded areas. Stock water ponds on this site frequently contain salty water. If feasible, alternative water sources should be developed.

Sandy range site. The principal grasses on this site are needleandthread and prairie sandreed. Other species are prairie junegrass, blue grama, western wheatgrass, green needlegrass, and upland sedges. The site generally has a number of early season forbs, such as western yarrow, green sagewort, and Missouri goldenrod. Woody plants, such as western snowberry and leadplant amorpha, make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, green needlegrass, prairie sandreed, and leadplant amorpha. The plants that increase in abundance under these conditions are blue grama, upland sedges, sand dropseed, and several forbs. Further deterioration results in a dominance of blue grama, upland sedges, and unpalatable forbs, such as western yarrow, green sagewort, and gray sagewort.

A low or moderate available water capacity is a concern in managing this site. Also, soil blowing is a hazard in denuded areas. Management that maintains the abundance and vigor of the naturally dominant species results in a natural plant community that provides excellent forage for livestock and a protective plant cover.

Shallow range site. A mixture of cool- and warm-season, mid grasses dominates this site. The principal species are western wheatgrass, needleandthread, and green needlegrass. Other species are plains muhly, blue grama, porcupinegrass, threadleaf sedge, and Pennsylvania sedge. Forbs make up about 10 percent of the total herbage. The site has only a small amount of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, needleandthread, and porcupinegrass. The plants that increase in abundance under these conditions are blue grama, western wheatgrass, red threeawn, and upland sedges. Further deterioration results in a dominance of blue grama, upland sedges, unpalatable forbs, and fringed sagewort.

Because of a limited available water capacity, forage production is limited on this site. It varies, depending on rainfall patterns. The site is fragile, and the plant community can deteriorate rapidly if poor management results in severe erosion. Management that keeps the plant community near its potential helps to control erosion and results in the best use of the available water.

Shallow to Gravel range site. A mixture of cool- and warm-season, mid grasses dominates this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are plains muhly, prairie junegrass, red threeawn, porcupinegrass, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has only a small amount of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, western wheatgrass, plains muhly, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, red threeawn, and upland sedges. Further deterioration results in a dominance of blue grama, Kentucky bluegrass, upland sedges, unpalatable forbs, and fringed sagebrush.

Because of a limited available water capacity, forage production is limited on this site. It varies, depending on rainfall patterns. The site is fragile, and the plant community can deteriorate rapidly. Because of the limited amount of available water, the plant community should be kept near its potential.

Silty range site. Mid grasses dominate this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are prairie junegrass, prairie dropseed, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has minor amounts of weedy species.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and porcupinegrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, threadleaf sedge, needleleaf sedge, and fringed sagebrush. Further deterioration results in a dominance of blue grama, Kentucky bluegrass, threadleaf sedge, needleleaf sedge, and varying amounts of fringed sagebrush, gray sagewort, and other forbs.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. These measures are also beneficial in areas where gullies have already formed. Areas where the site is in fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Subirrigated range site. Tall grasses dominate this site. The principal species are big bluestem, switchgrass, prairie cordgrass, little bluestem, and northern reedgrass. Other species are indiangrass, western wheatgrass, tall dropseed, and slender wheatgrass. The site has minor amounts of sedges and rushes. A variety of forbs makes up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, switchgrass, prairie cordgrass, northern reedgrass, indiangrass, and little bluestem. The plants that increase in abundance under these conditions are mat muhly, fowl bluegrass, Baltic rush, common spikerush, and undesirable forbs. Further deterioration results in a dominance of Kentucky bluegrass and other short grasses and grasslike plants and of undesirable forbs.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or a planned grazing system can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major grass species.

Thin Claypan range site. Short grasses dominate this site. The principal species are western wheatgrass, blue grama, inland saltgrass, and Sandberg bluegrass. Other species are prairie junegrass, needleandthread, Nuttall alkaligrass, alkali muhly, and needleleaf sedge. Forbs make up about 5 percent of the total herbage. The common woody plants are fringed sagebrush and cactus.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, prairie junegrass, and needleandthread. Plants that increase in abundance under these conditions are blue grama, inland saltgrass, Sandberg bluegrass, and alkali muhly. Further deterioration results in a dominance of short grasses, sedges, fringed sagebrush, broom snakeweed, and undesirable forbs.

Because of a high content of salts near the surface, productivity is quite low on this site. The site produces good-quality forage for cattle only if properly managed. If the site is in poor or fair condition, recovery is quite slow because of the salts and a dense, alkali subsoil. Stock water pits should not be constructed on this site because the water is likely to be salty. Careful management can maintain or restore the site to good or excellent condition. If the vegetation has been destroyed by cultivation or the site denuded, range seeding can restore the climax vegetation. Good seeding techniques are needed.

Thin Upland range site. Cool- and warm-season, mid grasses dominate this site. The principal species are little bluestem, needleandthread, western wheatgrass, and blue grama. Other species are plains muhly, sideoats grama, red threeawn, and upland sedges. Forbs make up about 10 percent of the herbage. The site has minor amounts of woody plants, such as silverberry and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as little bluestem, needleandthread, western wheatgrass, and sideoats grama. The plants that increase in abundance under these conditions are blue grama, red threeawn, upland sedges, and unpalatable forbs. Further deterioration results in a dominance of blue grama, Kentucky bluegrass, upland sedges, and fringed sagebrush.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies

can form along livestock trails. Fencing and improved grazing management help to prevent gullying. These measures are also beneficial in areas where gullies have already formed. Soil blowing is a problem in denuded areas. Areas where the site is in fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Very Shallow range site. The site has a mixture of cool- and warm-season, mid grasses. The principal species are needleandthread, western wheatgrass, blue grama, and plains muhly. Other species are prairie junegrass, red threeawn, sideoats grama, and upland sedges. Forbs and woody plants make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, western wheatgrass, sideoats grama, and plains muhly. The plants that increase in abundance under these conditions are blue grama, red threeawn, sand dropseed, and upland sedges. Further deterioration results in a dominance of blue grama, Kentucky bluegrass, red threeawn, upland sedges, and undesirable forbs and shrubs.

Available water capacity is very low on this site. Also, water erosion is a hazard in the more sloping areas. Gullies can easily form along cattle trails and in denuded areas. The site is frequently overgrazed. Once it is in fair or poor condition, it recovers slowly because of the very low available water capacity. Productivity can be maintained by careful management of the cool-season, mid grasses and by cross fencing, which helps to control livestock traffic patterns.

Wetland range site. Tall grasses dominate this site. The principal species are rivergrass, prairie cordgrass, northern reedgrass, slough sedge, and slim sedge. Other species are American mannagrass, American sloughgrass, Baltic rush, and common spikesedge. Common forbs are longroot smartweed and waterparsnip.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as rivergrass, slough sedge, prairie cordgrass, and northern reedgrass. The plants that increase in abundance under these conditions are slim sedge, Baltic rush, common spikesedge, and American sloughgrass. Further deterioration results in a dominance of Baltic rush, common spikesedge, and Mexican dock.

This site is easily damaged when it is wet. Grazing during wet periods results in soil compaction, trampling, and root shearing. Livestock are attracted to this site because of the supply of moisture. A planned grazing system and deferment of grazing when the site is wet help to maintain the climax vegetation and important wildlife habitat on this site.

Wet Meadow range site. Mid sedges dominate this site. The principal species are slim sedge, wooly sedge, fescue sedge, prairie cordgrass, and northern reedgrass. Other species are Baltic rush, common spikerush, fowl bluegrass, and switchgrass. Common forbs are Rydberg sunflower, tall white aster, and common wild mint.

Continual heavy grazing by cattle results in a decrease in the abundance of slim sedge, wooly sedge, northern reedgrass, prairie cordgrass, and switchgrass. The plants that increase in abundance under these conditions are fescue sedge, common spikerush, Baltic rush, mat muhly, and fowl bluegrass. Further deterioration results in a dominance of low-growing sedges, short grasses, western dock, and Canada thistle.

This site is easily damaged when it is wet. Grazing during wet periods results in compaction, trampling, and root shearing. Livestock are attracted to this site because of the supply of moisture. A planned grazing system and fencing help to maintain the climax vegetation. The site is an excellent source of quality hay.

Woodland, Windbreaks, and Environmental Plantings

Bruce C. Wight, forester, Soil Conservation Service, helped to prepare this section.

Barnes County has approximately 6,500 acres of native woodland *(8)*. Most of this woodland is in the valley of the Sheyenne River and its tributaries. Trees and shrubs also grow on the fringe of wetlands in the northern half of Barnes County. The woodland on the side slopes and draws of the river valley is primarily on Sinai silty clay loam, Kloten loam, Buse loam, and Edgeley loam. The woodland on bottom lands is mostly on LaDelle silty clay loam. The woodland on the fringe of the wetlands is mostly on Hamerly loam.

The bottom-land forest type is primarily American elm, green ash, boxelder, and various willow species. Other less common species include cottonwood, common chokecherry, highbush cranberry, redosier dogwood, and beaked hazel. Green ash and bur oak are the dominant woodland types along the side slopes of the Sheyenne River Valley. Quaking aspen and

paper birch types occur to a lessor degree. Quaking aspen clumps are restricted to steep, mainly northeast-facing slopes. Other trees and shrubs associated with these major tree species include hackberry, American basswood, hawthorn, ironwood, beaked hazel, American plum, chokecherry, juneberry, highbush cranberry, Wood's rose, snowberry, serviceberry, smooth sumac, silver buffaloberry, red raspberry, and redosier dogwood. The shrubs predominate in the upper reaches of the river valley in woody draws. The principal species in the woodland fringe of the wetlands in the county are quaking aspen, various willow species, and redosier dogwood.

Early settlers used the trees for fuel, lumber, and fenceposts. The principal current uses of trees is for protection and esthetic purposes. The trees protect the soil, homes, livestock, wildlife, and watersheds.

Windbreaks have been planted in Barnes County since the early days of settlement. Most of the early plantings were made to protect farmsteads and livestock. In the 1930's, approximately 2,300 acres was planted to trees and shrubs under the Prairie States Forestry Project of the United States Department of Agriculture, Forest Service.

Since the 1930's more than 5.5 million trees have been planted on about 8,000 acres by county farmers and landowners with the assistance of the Soil Conservation Service and the Barnes Soil Conservation District. Trees and shrubs are still needed around numerous farmsteads, but the major need is for windbreaks that help protect soils that are highly susceptible to soil blowing.

The following items should be considered before a planting is made: (1) the purpose of the planting, (2) the suitability of the soils, (3) the adaptability of the various species of trees and shrubs, (4) the location and design of the windbreak, and (5) selection of a source of hardy and adapted trees and shrubs. If these items are not considered, a poor or unsuccessful windbreak may result.

The establishment of a windbreak or an environmental planting and the growth of the trees and shrubs also depend on suitable site preparation and adequate maintenance after the trees and shrubs are planted. Grasses and weeds should be eliminated before the planting is made, and the competing vegetative regrowth of the ground cover should be controlled for the life of the windbreak. Some replanting of the trees and shrubs may be necessary during the first 2 years after planting.

Farmstead windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

David D. Dewald, biologist, Soil Conservation Service, helped to prepare this section.

The recreational resource of Barnes County is based mainly on the hunting, fishing, picnicking, and camping opportunities available on Lake Ashtabula. Boat rentals and resort housing are available on the lake.

The Barnes County Park Board maintains the Clausen Springs campground, which is adjacent to the Clausen Springs Wildlife Management Area and is managed by the North Dakota Game and Fish Department. This area provides fishing, hunting, and camping opportunities. Two campgrounds are available along Interstate 94. Four towns in the county have picnicking and limited camping facilities in local parks.

The Sheyenne River provides many recreational opportunities. Although access is somewhat limited, the river provides excellent fishing and canoeing. Groomed snowmobile trails are also available.

Hunting and limited fishing opportunities are provided on the approximately 5,000 acres of waterfowl production areas, 1,800 acres of wildlife management areas, and the 2,800 acres of land administered by the

North Dakota Department of University and School Lands.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils are gently sloping and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

David D. Dewald, biologist, Soil Conservation Service, helped to prepare this section.

Barnes County is in the prairie pothole region of North Dakota. The survey area has a diverse wildlife habitat base. Agricultural activity, since settlement, has reduced the quality and quantity of rangeland and wetland wildlife habitat but has increased the amount of openland wildlife habitat. About 4 percent of the original rangeland habitat remains, and a little less than 1 percent is native woodland habitat. Wildlife habitat and diversity are enhanced by the remaining wetlands and the riparian habitat along the Sheyenne River.

Drainage to improve crop production has removed approximately 40 percent of the original wetland habitat. The remaining wetlands provide habitat for waterfowl and furbearers. Large saline lakes in the central and north-central parts of the county provide excellent goose staging areas during spring and fall migrations.

Private landowners have planted thousands of miles of field shelterbelts to provide wildlife habitat. In addition, private landowners have protected approximately 17,000 acres of wetlands by conveying their drainage rights to the Federal government through the small-wetlands acquisition program. Private landowners manage many acres of upland and wetland primarily for wildlife. The expanded use of no-till and conservation tillage systems has increased the amount of food and cover available for migratory waterfowl and resident wildlife.

The public lands in Barnes County provide excellent wildlife habitat. The U.S. Fish and Wildlife Service manages about 5,300 acres as waterfowl production areas and 4,500 acres as refuges. The North Dakota Game and Fish Department manages approximately

1,800 acres of State-owned wildlife management areas.

Important game bird species in the survey area are gray partridge, ring-necked pheasant, ducks, geese, mourning dove, sharp-tailed grouse, and sandhill crane. Mammals that are hunted include red fox, coyote, white-tailed deer, muskrat, mink, raccoon, badger, cottontail rabbit, and white-tailed jackrabbit.

A wide variety of fish species live in the waters of the survey area. Northern pike, walleyed pike, yellow perch, white bass, largemouth and smallmouth bass, bullhead, muskellunge, rainbow trout, channel catfish, bluegill, crappie, and rock bass are the major species. The majority of the fish are in public lakes and the Sheyenne River; however, some are in the numerous small ponds in the county. The potential for developing additional fishery resources is limited.

About 175,470 acres, or about 18 percent, of the land in Barnes County meets the requirements of soils with hydric conditions. The map units in the survey area that generally display hydric conditions are listed at the end of this paragraph. The hydric conditions are evident or present unless the soil has been artificially drained or otherwise altered such that it no longer supports a predominance of hydrophytic vegetation. The soil map does not identify drained areas, nor does the list constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4, and the location is shown on the detailed soil maps at the back of this survey. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units."

2	Tonka silt loam
3	Parnell silty clay loam
6	Southam silty clay loam
19	Colvin silty clay loam, saline
26	Colvin silty clay loam
36	Fargo silty clay
50	Hamerly-Tonka complex, 0 to 3 percent slopes (Tonka part)
54	Lamoure silt loam, channeled
71	Vallers-Parnell complex
77	Vallers loam, saline
80	Marysland loam
84	Easby loam
88	Manfred and Vallers soils, extremely stony
90	Dovray silty clay
91	Arveson loam

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, sunflowers, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are intermediate and tall wheatgrasses, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, western wheatgrass, and blue grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are common chokecherry, buffaloberry, snowberry, and juneberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, common reedgrass, saltgrass, prairie cordgrass, bulrushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include gray partridge, pheasant, western meadowlark, lark bunting, cottontail, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include deer, sharp-tailed grouse, western meadowlark, and grasshopper sparrow.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground

cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil

properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal

of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce water erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in

parentheses, is given in table 17.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum

average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.

8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months.

The information is based on evidence in the soil

profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the North Dakota State Highway Department Laboratory.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(19)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploborolls (*Hapl*, meaning minimal horizonation, plus *boroll*, the suborder of the Mollisols that has a frigid temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Udic* identifies the subgroup that has a udic moisture regime. An example is Udic Haploborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed Udic Haploborolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (17)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (19)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Arveson Series

The Arveson series consists of deep, poorly drained, highly calcareous soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope is 0 to 1 percent.

Typical pedon of Arveson loam, 1,815 feet south and 800 feet east of the northwest corner of sec. 14, T. 138 N., R. 61 W.

A—0 to 6 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores; strongly effervescent; mildly alkaline; clear smooth boundary.

ABk—6 to 15 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; violently effervescent; moderately alkaline; clear smooth boundary.

Bk1—15 to 23 inches; light brownish gray (2.5Y 6/2) loam, light gray (2.5Y 7/2) dry; few medium distinct yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common soft masses of lime; violently effervescent; moderately alkaline; clear wavy boundary.

Bk2—23 to 36 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; many medium distinct light olive brown (2.5Y 5/4) and dark brown (10YR 4/3) mottles; weak medium prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; common soft masses of lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C—36 to 48 inches; grayish brown (2.5Y 5/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; many medium distinct light olive brown (2.5Y 5/4) mottles; single grain; loose, nonsticky and nonplastic; slightly effervescent; moderately alkaline; clear smooth boundary.

2Cg—48 to 60 inches; gray (5Y 5/1) clay loam, light brownish gray (2.5Y 6/2) dry; many large prominent strong brown (7.5YR 5/6) mottles; massive; hard, firm, slightly sticky and slightly plastic; slightly effervescent; moderately alkaline.

The A horizon has hue of 10YR to 5Y and value of 2 or 3 (3 or 4 when dry). The ABk horizon has hue of 10YR to 5Y and value of 2 to 4. The Bk horizon has hue of 2.5Y or 5Y and chroma of 1 or 2. The C horizon has value of 4 to 6. It is loamy fine sand, loamy sand, fine sandy loam, or sandy loam within a depth of 40 inches and clay loam or loam below that depth.

Barnes Series

The Barnes series consists of deep, well drained, moderately slowly permeable soils on till plains and moraines and in stream valleys. These soils formed in glacial till. Slope ranges from 0 to 25 percent.

Typical pedon of Barnes loam, in an area of Barnes-Svea loams, 2 to 6 percent slopes; 140 feet west and 1,620 feet south of the northeast corner of sec. 21, T. 140 N., R. 57 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; mildly alkaline; abrupt smooth boundary.

Bw1—7 to 12 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; about 3 percent gravel; mildly alkaline; clear wavy boundary.

Bw2—12 to 15 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine pores; about 5 percent gravel; mildly alkaline; gradual wavy boundary.

Bk1—15 to 19 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few roots; common pores; about 5 percent gravel; lime disseminated throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk2—19 to 29 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; about 5 percent gravel;

few soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

C—29 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; few fine distinct gray (5Y 6/1) relict mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 8 percent gravel; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 when dry). It has chroma of 1 in the upper part and 1 or 2 in the lower part. The Bw horizon has hue of 10YR or 2.5Y and value of 2 to 4 (3 to 5 when dry). The Bk horizon has value of 4 to 6 and chroma of 2 to 4. Some pedons have a BCk horizon. The C horizon has value of 4 or 5 (5 to 7 when dry) and chroma of 2 to 4. It is loam or clay loam.

Bearden Series

The Bearden series consists of deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on lake plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Bearden silty clay loam, 450 feet north and 1,000 feet east of the southwest corner of sec. 24, T. 141 N., R. 58 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; many fine and very fine roots; many fine and very fine pores; disseminated lime throughout; slightly effervescent; moderately alkaline; abrupt smooth boundary.

Bk1—9 to 18 inches; grayish brown (2.5Y 5/2) silty clay loam, light olive gray (5Y 6/2) dry; moderate medium angular blocky structure; slightly hard, friable, sticky and plastic; common fine and very fine roots; common fine and very fine pores; disseminated lime throughout; violently effervescent; moderately alkaline; clear wavy boundary.

Bk2—18 to 23 inches; light olive brown (2.5Y 5/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; common fine and very fine roots; common fine and very fine pores; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk3—23 to 32 inches; light olive brown (2.5Y 5/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct dark yellowish brown (10YR 4/4) and common fine prominent gray (5Y 5/1) mottles; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; few fine and very fine roots; few fine and very fine pores; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

C1—32 to 39 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; many medium distinct gray (5Y 5/1) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few fine and very fine pores; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

C2—39 to 46 inches; light olive brown (2.5Y 5/4) silty clay loam, pale yellow (2.5Y 7/4) dry; many medium distinct gray (5Y 5/1) mottles; massive; slightly hard, friable, sticky and plastic; disseminated lime throughout; mildly alkaline; gradual wavy boundary.

C3—46 to 60 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; many medium distinct gray (5Y 5/1) mottles; massive; slightly hard, friable, sticky and plastic; disseminated lime throughout; strongly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 17 inches. The A horizon has value of 2 or 3 (3 or 4 when dry). The Bk horizon has hue of 10YR to 5Y and value of 4 or 5 (5 to 7 when dry). Some pedons have a Bky horizon. The C horizon has value of 5 or 6 (5 to 7 when dry). Some pedons are saline.

Buse Series

The Buse series consists of deep, well drained, moderately slowly permeable soils on till plains and moraines and in stream valleys. These soils formed in glacial till. Slope ranges from 3 to 35 percent.

Typical pedon of Buse loam, in an area of Buse-Barnes loams, 15 to 35 percent slopes; 1,190 feet west and 10 feet north of the southeast corner of sec. 23, T. 140 N., R. 58 W.

A—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; about 5 percent gravel; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk1—6 to 11 inches; dark grayish brown (2.5Y 4/2)

loam, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; about 5 percent gravel; lime disseminated throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk2—11 to 21 inches; grayish brown (2.5Y 5/2) loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine pores; about 5 percent gravel; common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

BCk—21 to 31 inches; grayish brown (2.5Y 5/2) loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent yellowish red (5YR 5/8) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

C—31 to 60 inches; grayish brown (2.5Y 5/2) loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent strong brown (7.5YR 5/8) relict mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 10 percent gravel; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 10 inches. The A horizon has value of 2 or 3 (4 or 5 when dry). It has chroma of 1 in the upper part and 1 or 2 in the lower part. The Bk and C horizons are loam or clay loam. The Bk horizon has hue of 10YR or 2.5Y. The C horizon has hue of 2.5Y or 5Y and value of 4 or 5 (5 to 7 when dry).

Cavour Series

The Cavour series consists of deep, moderately well drained, slowly permeable, alkali soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Cavour loam, in an area of Svea-Cavour loams, 0 to 3 percent slopes; 420 feet west and 945 feet north of the southeast corner of sec. 10, T. 137 N., R. 59 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine and common medium roots; many very fine and common fine pores; slightly acid; abrupt smooth boundary.

E—6 to 9 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate thin platy structure; soft, friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine and few fine pores; neutral; abrupt smooth boundary.

Bt1—9 to 16 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium and coarse prismatic structure parting to moderate medium angular blocky; extremely hard, very firm, sticky and plastic; many very fine and few fine roots; common very fine pores; common distinct clay films on faces of peds; dark grayish brown (10YR 4/2) coatings on faces of peds; mildly alkaline; clear smooth boundary.

Bt2—16 to 19 inches; dark gray (5Y 4/1) clay loam, gray (5Y 5/1) dry; moderate medium prismatic structure parting to strong medium subangular blocky; hard, very firm, sticky and plastic; common very fine roots; few very fine pores; few faint clay films on faces of peds; olive gray (5Y 5/2) coatings on faces of peds; moderately alkaline; clear smooth boundary.

Bkz1—19 to 26 inches; olive gray (5Y 4/2) loam, olive gray (5Y 5/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; few very fine pores; many medium and fine masses of salts; disseminated lime throughout; violently effervescent; moderately alkaline; clear wavy boundary.

Bkz2—26 to 33 inches; olive (5Y 5/3) loam, pale olive (5Y 6/3) dry; few fine prominent olive brown (2.5Y 4/4) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; few fine masses of salts; disseminated lime throughout; violently effervescent; moderately alkaline; clear wavy boundary.

Bk—33 to 38 inches; olive (5Y 5/3) loam, pale olive (5Y 6/3) dry; few fine prominent yellowish brown (10YR 5/8) and common fine distinct gray (5Y 6/1) mottles; weak medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few soft masses of lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C—38 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; many medium prominent gray (5Y 6/1) and few fine prominent yellowish brown (10YR 5/8) mottles; massive; slightly hard, firm, slightly sticky and slightly plastic;

strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 15 to 25 inches. The depth to gypsum or other salts ranges from 16 to 43 inches.

The A horizon has value of 2 or 3 (3 or 4 when dry). The E horizon has chroma of 1 or 2. It is loam or silt loam. The Bt horizon has chroma of 1 or 2. It is clay loam or silty clay loam. The Bk horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 to 7 when dry), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 to 7 when dry), and chroma of 3 or 4.

Colvin Series

The Colvin series consists of deep, poorly drained, moderately slowly permeable, highly calcareous soils on lake plains and in outwash channels. These soils formed in glaciofluvial and glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Colvin silty clay loam, 125 feet south and 2,070 feet west of the northeast corner of sec. 1, T. 139 N., R. 58 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores; slightly effervescent; moderately alkaline; abrupt smooth boundary.

A—7 to 11 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; many fine and very fine roots; many fine and very fine pores; slightly effervescent; moderately alkaline; clear smooth boundary.

ABk—11 to 16 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; common fine and very fine roots; common fine and very fine pores; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Bkyz—16 to 22 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/4) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; few fine and very fine roots; common irregular soft masses of gypsum and salts; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

BCk—22 to 31 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; few distinct yellowish brown (10YR 5/4) mottles; massive; hard, friable, sticky and plastic; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

C—31 to 48 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (5Y 7/2) dry; many coarse prominent yellowish brown (10YR 5/8) mottles; massive; hard, friable, sticky and plastic; slightly effervescent; moderately alkaline; clear smooth boundary.

2Cg1—48 to 55 inches; gray (5Y 5/1) sandy loam, light olive gray (5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, very friable, slightly sticky and slightly plastic; very slightly effervescent; moderately alkaline; clear smooth boundary.

3Cg2—55 to 60 inches; gray (5Y 5/1) silty clay loam, light gray (5Y 7/2) dry; many medium prominent yellowish brown (10YR 5/8) mottles; massive; hard, friable, sticky and plastic; slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 14 inches. The A horizon has value of 2 or 3 (3 or 4 when dry). The Bkyz horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 to 7 when dry), and chroma of 1 or 2. It is silty clay loam or silt loam. The C horizon has value of 5 or 6 (5 to 7 when dry) and chroma of 1 to 3. It is silt loam or silty clay loam within a depth of 40 inches and silty clay loam, loam, or sandy loam below that depth. Some pedons are saline.

Divide Series

The Divide series consists of deep, somewhat poorly drained, highly calcareous soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope is 0 to 1 percent.

Typical pedon of Divide loam, 200 feet south and 890 feet west of the northeast corner of sec. 2, T. 142 N., R. 56 W.

A1—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine

pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

A2—7 to 11 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; slightly effervescent; mildly alkaline; clear wavy boundary.

Bk1—11 to 21 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine pores; common soft masses of lime; violently effervescent; mildly alkaline; clear wavy boundary.

Bk2—21 to 28 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; few large prominent yellowish brown (10YR 5/8) and brownish yellow (10YR 6/8) mottles; weak fine subangular blocky structure; hard, friable, sticky and slightly plastic; about 5 percent gravel; disseminated lime throughout; slightly effervescent; mildly alkaline; gradual wavy boundary.

2C—28 to 60 inches; olive brown (2.5Y 4/4) gravelly coarse sand, light olive brown (2.5Y 5/4) dry; single grain; loose, nonsticky and nonplastic; about 25 percent gravel; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 8 to 16 inches. The depth to sand and gravel ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (4 or 5 when dry). The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (6 or 7 when dry), and chroma of 1 or 2. The content of gravel in the lower part of this horizon is 5 to 15 percent. The 2C horizon has hue of 10YR to 5Y.

Dovray Series

The Dovray series consists of deep, very poorly drained, very slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Dovray silty clay, 2,250 feet south and 680 feet west of the northeast corner of sec. 11, T. 137 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard, firm, very sticky and very plastic; many very fine roots; neutral; abrupt smooth boundary.

AB—8 to 20 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong very fine and fine angular blocky structure; slightly hard, firm, very sticky and very plastic; common very fine roots; vertical tongues of A horizon material throughout; neutral; gradual wavy boundary.

Bg1—20 to 40 inches; very dark gray (5Y 3/1) silty clay, dark gray (5Y 4/1) dry; strong very fine and fine angular blocky structure; hard, firm, very sticky and very plastic; few fine roots; vertical tongues of A horizon material throughout; mildly alkaline; gradual wavy boundary.

Bg2—40 to 45 inches; dark gray (5Y 4/1) silty clay, olive gray (5Y 5/2) dry; moderate very fine and fine angular blocky structure; slightly hard, firm, very sticky and very plastic; few fine roots; vertical tongues of A horizon material throughout; mildly alkaline; gradual wavy boundary.

Cg1—45 to 50 inches; gray (5Y 5/1) silty clay, light gray (5Y 6/1) dry; many large prominent dark yellowish brown (10YR 4/4) mottles; massive; very hard, friable, very sticky and very plastic; vertical tongues of A horizon material throughout; mildly alkaline; gradual wavy boundary.

Cg2—50 to 60 inches; gray (5Y 5/1) silty clay, light olive gray (5Y 6/2) dry; many medium prominent very pale brown (10YR 8/4) mottles; massive; very hard, firm, very sticky and very plastic; vertical tongues of A horizon material extending into this horizon; few medium soft masses of lime; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 50 inches. The A horizon has value of 2 or 3. The Bg horizon has hue of 2.5Y to 5Y, value of 3 or 4 (3 to 5 when dry), and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y and value of 4 to 6. The content of gravel in this horizon is 0 to 5 percent.

Easby Series

The Easby series consists of deep, poorly drained, moderately slowly permeable, highly calcareous, saline soils on till plains. These soils formed in glacial till. Slope is 0 to 1 percent.

Typical pedon of Easby loam, 175 feet north and 140 feet west of the southeast corner of sec. 13, T. 138 N., R. 57 W.

A—0 to 2 inches; black (10YR 2/1) loam, dark gray

(10YR 4/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; slightly effervescent; moderately alkaline; clear smooth boundary.

Akz—2 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores; common masses of salts; disseminated lime throughout; strongly effervescent; moderately alkaline; irregular wavy boundary.

ABkz—8 to 16 inches; dark gray (10YR 4/1) loam, gray (10YR 5/1) dry; weak medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky and plastic; common fine and very fine roots; common fine and very fine pores; many masses of salts; common soft masses of lime; violently effervescent; moderately alkaline; irregular wavy boundary.

Bky—16 to 22 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; few medium distinct light olive brown (2.5Y 5/4) mottles; weak medium and fine angular blocky structure; very hard, friable, sticky and plastic; few fine and very fine roots; few fine pores; many masses of gypsum; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

BCy—22 to 32 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; common large prominent light olive brown (2.5Y 5/6) mottles; massive; very hard, friable, sticky and plastic; many masses of gypsum; slightly effervescent; moderately alkaline; gradual wavy boundary.

C—32 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; many large prominent olive yellow (2.5YR 6/6) mottles; massive; very hard, friable, sticky and plastic; about 3 percent gravel; slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The C horizon is loam or clay loam within a depth of 40 inches and silt loam, loam, silty clay loam, very fine sand, clay loam, or clay below that depth.

Edgeley Series

The Edgeley series consists of moderately deep, well drained, moderately permeable soils on till plains. These soils formed in glacial till and material weathered from shale. Slope ranges from 2 to 6 percent.

Typical pedon of Edgeley loam, 2 to 6 percent slopes, 2,505 feet east and 1,120 feet south of the northwest corner of sec. 9, T. 139 N., R. 58 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores; neutral; abrupt smooth boundary.

BA—8 to 15 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; common fine and very fine pores; mildly alkaline; clear smooth boundary.

Bw1—15 to 23 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, sticky and slightly plastic; common fine and very fine roots; common fine and very fine pores; moderately alkaline; gradual wavy boundary.

2Bw2—23 to 32 inches; very dark grayish brown (2.5Y 3/2) channery silty clay loam, dark grayish brown (2.5Y 4/2) dry; weak medium blocky structure; hard, firm, sticky and plastic; few fine and very fine roots; few fine and very fine pores; about 35 percent shale fragments; common soft masses of lime; slightly effervescent; moderately alkaline; gradual wavy boundary.

2Cr—32 to 60 inches; very dark grayish brown (2.5Y 3/2) shale bedrock, grayish brown (2.5Y 5/2) dry; few roots in partings and on the surface of individual shale particles; lime on the surface of some shale particles; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to shale bedrock ranges from 20 to 40 inches.

Egeland Series

The Egeland series consists of deep, well drained, moderately rapidly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 1 to 6 percent.

Typical pedon of Egeland fine sandy loam, 1 to 6 percent slopes, 170 feet south and 2,200 feet west of the northeast corner of sec. 6, T. 140 N., R. 57 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; neutral; abrupt smooth boundary.

Bw1—9 to 13 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; mildly alkaline; clear smooth boundary.

Bw2—13 to 18 inches; olive brown (2.5Y 4/4) fine sandy loam, light olive brown (2.5Y 5/4) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; mildly alkaline; clear smooth boundary.

Bk1—18 to 30 inches; light olive brown (2.5Y 5/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; weak medium and coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; violently effervescent; disseminated lime throughout; mildly alkaline; clear smooth boundary.

Bk2—30 to 40 inches; light olive brown (2.5Y 5/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; weak coarse subangular blocky structure; soft, slightly hard, nonsticky and nonplastic; disseminated lime throughout; strongly effervescent; mildly alkaline; clear smooth boundary.

C—40 to 60 inches; light olive brown (2.5Y 5/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard, very friable, nonsticky and nonplastic; disseminated lime throughout; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 8 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 when dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 when dry), and chroma of 1 to 4. The Bk horizon has value of 4 or 5 (6 or 7 when dry) and chroma of 2 to 4. Some pedons have a BCk horizon. The C horizon has value of 4 or 5 (6 or 7 when dry) and chroma of 2 to 4. It is fine sandy loam or sandy loam. It has coarser or finer textures below a depth of 40 inches in some pedons.

Exline Series

The Exline series consists of deep, somewhat poorly drained, very slowly permeable, alkali soils on lake plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Exline silty clay loam, 195 feet west and 630 feet north of the southeast corner of sec. 7, T. 139 N., R. 58 W.

Ap—0 to 5 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine angular blocky structure; very hard, friable, sticky and plastic; common very fine roots; few fine pores; few fine masses of salts; mildly alkaline; clear smooth boundary.

Btz1—5 to 11 inches; very dark grayish brown (2.5Y 3/2) silty clay, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to strong fine angular blocky; extremely hard, friable, sticky and plastic; common fine roots; common fine pores; many distinct clay films on faces of peds; many very dark brown (10YR 2/2) coatings on faces of peds; few fine masses of salts; moderately alkaline; clear smooth boundary.

Btz2—11 to 15 inches; very dark grayish brown (2.5Y 3/2) silty clay, dark grayish brown (2.5Y 4/2) dry; moderate medium prismatic structure parting to fine and very fine medium angular blocky; extremely hard, friable, sticky and plastic; few very fine roots; common very fine pores; common faint clay films on faces of peds; common fine masses of salts; slightly effervescent; moderately alkaline; clear wavy boundary.

Bkz—15 to 25 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; weak medium prismatic structure parting to moderate fine angular blocky; extremely hard, firm, sticky and plastic; few fine roots; common very fine pores; common medium masses of salts; many fine and few medium soft masses of lime; strongly effervescent; moderately alkaline; clear wavy boundary.

Bky—25 to 36 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; extremely hard, firm, sticky and plastic; few fine roots; common very fine pores; common medium soft masses of gypsum; common medium soft masses of lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

BC—36 to 50 inches; grayish brown (2.5Y 5/2) silty clay loam, pale yellow (5Y 7/3) dry; common fine faint yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; very hard, firm, sticky

and plastic; slightly effervescent; moderately alkaline; gradual wavy boundary.

Cy—50 to 60 inches; grayish brown (2.5Y 5/2) silt loam, pale yellow (5Y 7/3) dry; many fine prominent yellowish brown (10YR 5/6) and many fine and large prominent light yellowish brown (2.5Y 6/4) mottles; massive; very hard, firm, slightly sticky and slightly plastic; common medium masses of gypsum; few fine soft masses of lime; strongly effervescent; moderately alkaline.

The depth to carbonates ranges from 11 to 15 inches. The A horizon has value of 2 or 3 (4 or 5 when dry). Undisturbed pedons have an E horizon 1 to 3 inches thick. The Btz horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 or 4 when dry). The Bk horizon has chroma of 2 or 3. It is silty clay, silty clay loam, or clay loam. The C horizon has hue of 2.5Y or 5Y and value of 4 or 5 (6 or 7 when dry). It is silty clay loam, silt loam, or clay loam.

Fargo Series

The Fargo series consists of deep, poorly drained, slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Fargo silty clay, 1,850 feet west and 310 feet south of the northeast corner of sec. 11, T. 137 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak coarse and medium angular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots; many very fine and fine pores; mildly alkaline; abrupt smooth boundary.

Bw1—8 to 12 inches; very dark brown (10YR 2/2) silty clay, very dark gray (10YR 3/1) dry; weak coarse prismatic structure parting to strong fine and very fine angular blocky; hard, firm, sticky and plastic; many very fine and fine roots; many very fine and fine pores; vertical tongues of A horizon material throughout; mildly alkaline; clear wavy boundary.

Bw2—12 to 19 inches; dark grayish brown (2.5Y 4/2) and very dark gray (10YR 3/1) silty clay, grayish brown (2.5Y 5/2) and dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to moderate fine and very fine angular blocky; hard, firm, sticky and plastic; common very fine and fine roots; common very fine and fine pores; vertical tongues of A horizon material throughout; slightly effervescent; moderately alkaline; gradual wavy boundary.

Bk1—19 to 30 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate medium and fine angular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; few very fine and fine pores; vertical tongues of A horizon material throughout; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk2—30 to 37 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; common very fine and fine pores; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Cg1—37 to 44 inches; olive gray (5Y 4/2) silty clay, light olive gray (5Y 6/2) dry; many medium prominent yellowish brown (10YR 5/6) and few fine faint gray (5Y 5/1) mottles; massive; hard, firm, sticky and plastic; disseminated lime throughout; few masses of gypsum; strongly effervescent; moderately alkaline; gradual wavy boundary.

Cg2—44 to 49 inches; olive gray (5Y 4/2) silty clay, light olive gray (5Y 6/2) dry; many large prominent yellowish brown (10YR 5/6) and few fine faint gray (5Y 5/1) mottles; massive; very hard, firm, sticky and plastic; slightly effervescent; moderately alkaline; gradual wavy boundary.

Cg3—49 to 60 inches; olive gray (5Y 4/2) clay, light olive gray (5Y 6/2) dry; many medium prominent yellowish brown (10YR 5/6) and few fine faint gray (5Y 5/1) mottles; massive; very hard, firm, sticky and plastic; few masses of gypsum; disseminated lime throughout; violently effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 8 to 24 inches. The A horizon has value of 3 or 4 when dry. The Bw horizon has value of 3 to 5 when dry. The Bw horizon is mottled in some pedons. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 or 6 when dry), and chroma of 2 or 3.

Fordville Series

The Fordville series consists of deep, well drained soils on outwash plains and terraces. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and rapid in

the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Fordville loam, 0 to 3 percent slopes, 485 feet north and 2,250 feet east of the southwest corner of sec. 11, T. 142 N., R. 58 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; neutral; abrupt smooth boundary.

Bw1—7 to 16 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate coarse and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine and few fine pores; mildly alkaline; clear smooth boundary.

Bw2—16 to 21 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; strong coarse and medium prismatic structure parting to moderate coarse and medium subangular blocky; hard, firm, slightly sticky and slightly plastic; many very fine roots; many very fine and few fine pores; mildly alkaline; gradual smooth boundary.

Bk—21 to 33 inches; light brownish gray (2.5Y 6/2) loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, firm, slightly sticky and slightly plastic; common very fine roots; many very fine and few fine pores; violently effervescent; disseminated lime throughout; moderately alkaline; abrupt wavy boundary.

2C1—33 to 52 inches; dark grayish brown (10YR 4/2) sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; about 10 percent gravel; disseminated lime throughout; strongly effervescent; mildly alkaline; abrupt wavy boundary.

2C2—52 to 55 inches; dark brown (10YR 3/3) very gravelly sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; about 40 percent gravel; disseminated lime throughout; strongly effervescent; mildly alkaline; abrupt wavy boundary.

2C3—55 to 60 inches; very dark grayish brown (2.5Y 3/2) very gravelly sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky and nonplastic; about 35 percent gravel; disseminated lime throughout; strongly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 16 to 24 inches. The depth to sand and gravel ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 or 4 when dry). It has chroma of 1 in the upper part and 1 or 2 in the lower part. The Bw horizon has value of 2 to 4 and chroma of 2 or 3. It is loam or clay loam. The Bk horizon has value of 5 or 6 (7 or 8 when dry) and chroma of 2 or 3. The 2C horizon has value of 4 or 5 when dry and chroma of 2 to 4. It is loamy sand, sand, gravelly coarse sand, very gravelly sand, gravelly sand, or gravelly loamy sand.

Gardena Series

The Gardena series consists of deep, moderately well drained, moderately permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 6 percent.

Typical pedon of Gardena silt loam, 385 feet west and 420 feet south of the northeast corner of sec. 15, T. 141 N., R. 58 W.

A1—0 to 10 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; neutral; clear wavy boundary.

A2—10 to 24 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; moderate coarse and medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine pores; mildly alkaline; gradual wavy boundary.

Bw—24 to 34 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine pores; mildly alkaline; gradual wavy boundary.

Bk—34 to 44 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common soft masses of lime; violently effervescent; mildly alkaline; gradual wavy boundary.

C1—44 to 54 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; slightly hard, friable, slightly sticky and slightly plastic;

strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—54 to 60 inches; light olive brown (2.5Y 5/4) stratified silt loam and very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; slightly hard, very friable, slightly sticky and nonplastic; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 40 inches. The A horizon has value of 2 or 3 (3 or 4 when dry). It has chroma of 1 in the upper part and 1 or 2 in the lower part. The Bw horizon has value of 2 or 3 (3 or 4 when dry) and chroma of 1 or 2. The Bk horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 when dry), and chroma of 2 to 4. The B horizon is silt loam, loam, or very fine sandy loam. The C horizon has value of 5 or 6 (5 to 7 when dry) and chroma of 2 to 4. It is silt loam, fine sand, very fine sandy loam, silty clay loam, or loamy very fine sand.

Glyndon Series

The Glyndon series consists of deep, somewhat poorly drained, moderately permeable, highly calcareous soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Glyndon silt loam, 175 feet south and 2,315 feet east of the northwest corner of sec. 1, T. 140 N., R. 58 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; slightly effervescent; moderately alkaline; abrupt smooth boundary.

AB—8 to 11 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to moderate coarse and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bk1—11 to 23 inches; dark grayish brown (2.5Y 4/2) silt loam, gray (10YR 5/1) dry; moderate coarse and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine pores; common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk2—23 to 28 inches; grayish brown (2.5Y 5/2) silt loam, gray (10YR 6/1) dry; moderate coarse and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common very fine and fine pores; common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

C1—28 to 41 inches; light yellowish brown (2.5Y 6/4) silt loam, light gray (2.5Y 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; strongly effervescent; mildly alkaline; gradual wavy boundary.

C2—41 to 50 inches; light olive brown (2.5Y 5/4) silt loam, light brownish gray (2.5Y 6/2) dry; common fine distinct yellowish brown (10YR 5/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; strongly effervescent; mildly alkaline; gradual wavy boundary.

C3—50 to 60 inches; light olive brown (2.5Y 5/4) very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; many medium prominent yellowish brown (10YR 5/8) mottles; slightly hard, friable, nonsticky and nonplastic; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 12 inches. The A horizon has value of 2 or 3 (3 or 4 when dry). The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 7 when dry, and chroma of 1 to 4. Some pedons have a Bky horizon. The C horizon has value of 5 to 7 when dry. It is silt loam or silty clay loam within a depth of 40 inches and fine sand, very fine sandy loam, silty clay loam, silt loam, or loamy very fine sand below that depth. Some pedons are saline.

Hamerly Series

The Hamerly series consists of deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on till plains (fig. 9). These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Hamerly loam, in an area of Hamerly-Tonka complex, 0 to 3 percent slopes; 145 feet north and 185 feet west of the southeast corner of sec. 12, T. 142 N., R. 57 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and very fine granular structure; slightly hard, friable, slightly

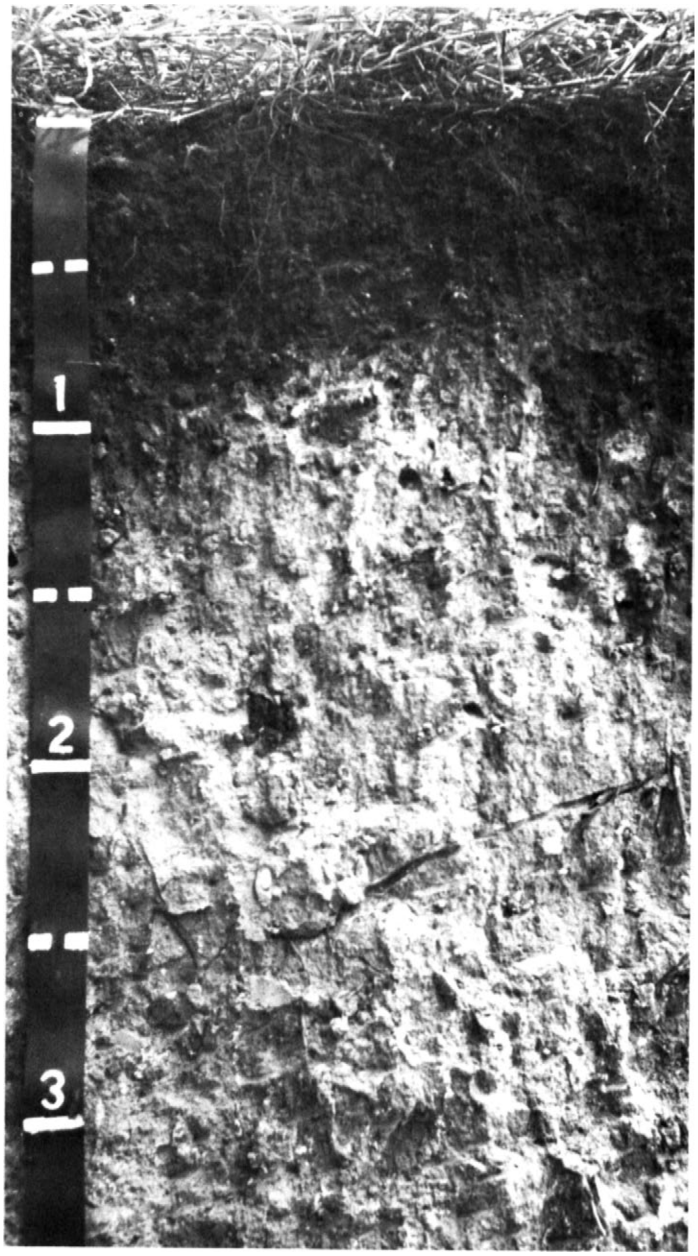

Figure 9.—Profile of a Hamerly soil, which has a black surface layer and accumulated lime in the subsoil. Depth is marked in feet.

sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; slightly effervescent; moderately alkaline; abrupt smooth boundary.

Bk—7 to 16 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine pores; about 2 percent gravel; violently effervescent; disseminated lime throughout; moderately alkaline; gradual wavy boundary.

Bky—16 to 25 inches; light olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) dry; few fine distinct light yellowish brown (10YR 6/4) mottles; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine pores; about 2 percent gravel; common masses of gypsum; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

By—25 to 37 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; few medium prominent reddish brown (5YR 5/3) mottles; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; about 2 percent gravel; common masses of gypsum; slightly effervescent; moderately alkaline; gradual wavy boundary.

C1—37 to 47 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; few large prominent reddish brown (5YR 5/3) mottles; massive; hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—47 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; many large prominent red (2.5YR 5/6) and gray (5Y 5/1) mottles; massive; hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 14 inches. The A horizon has value of 2 or 3 (3 to 5 when dry). The Bk horizon has hue of 10YR to 5Y, value of 3 to 6 (5 to 7 when dry), and chroma of 1 to 4. The Bky horizon has value of 5 or 6 (7 or 8 when dry). Some pedons do not have a Bky horizon. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 2 to 4.

Kloten Series

The Kloten series consists of shallow, well drained, moderately permeable soils in stream valleys. These

soils formed in material weathered from shale. Slope ranges from 9 to 35 percent.

Typical pedon of Kloten silty clay loam, in an area of Kloten-Buse complex, 9 to 35 percent slopes; 1,710 feet east and 190 feet south of the northwest corner of sec. 33, T. 138 N., R. 58 W.

A—0 to 5 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; weak fine and very fine subangular blocky structure; hard, friable, sticky and plastic; many very fine and fine roots; many very fine and fine pores; about 2 percent shale fragments; strongly effervescent; moderately alkaline; clear wavy boundary.

AC—5 to 10 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; moderate very fine and fine subangular blocky structure; very hard, firm, very sticky and very plastic; common very fine and fine roots; common very fine and fine pores; about 10 percent shale fragments; strongly effervescent; moderately alkaline; clear wavy boundary.

C—10 to 16 inches; dark gray (5Y 4/1) very channery silty clay loam, gray (5Y 5/1) dry; weak medium subangular blocky structure; hard, friable, sticky and plastic; few fine and very fine roots; yellowish brown (10YR 5/6) stains on surface of some shale fragments; about 55 percent shale fragments; strongly effervescent; moderately alkaline; clear wavy boundary.

R—16 to 60 inches; dark gray (5Y 4/1) shale bedrock, gray (5Y 5/1) dry; an occasional root in partings; yellowish brown (10YR 5/6) stains on surface of some shale fragments; slightly effervescent on the surfaces of shale fragments.

The depth to shale bedrock ranges from 12 to 20 inches. The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (4 or 5 when dry). The C horizon has hue of 2.5Y or 5Y and value of 3 or 4 (5 or 6 when dry).

Kranzburg Series

The Kranzburg series consists of deep, well drained, moderately slowly permeable soils on till plains. These soils formed in glaciolacustrine deposits and glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Kranzburg silty clay loam, in an area of Kranzburg-Lismore silty clay loams, 2 to 6 percent slopes; 470 feet west and 105 feet south of the northeast corner of sec. 15, T. 137 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; many fine and very fine roots; many fine and very fine pores; neutral; abrupt smooth boundary.

Bw1—8 to 11 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky and plastic; common fine and very fine pores; many distinct black (10YR 2/1) coatings on faces of peds; vertical tongues of A horizon material throughout; mildly alkaline; clear smooth boundary.

Bw2—11 to 19 inches; dark grayish brown (10YR 4/2) silty clay loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; common fine and very fine roots; common fine and very fine pores; common distinct black (10YR 2/1) coatings on faces of peds; vertical tongues of A horizon material throughout; mildly alkaline; gradual wavy boundary.

2Bk1—19 to 23 inches; brown (10YR 5/3) clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common fine and very fine roots; common fine and very fine pores; about 5 percent gravel; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

2Bk2—23 to 34 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; about 5 percent gravel; many fine soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

2C1—34 to 43 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; few fine soft masses of lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

2C2—43 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; few large prominent yellowish brown (10YR 5/8) mottles; massive; hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; disseminated lime throughout; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 when dry) and chroma of 1. The Bw horizon has hue of 10YR or 2.5Y and value of 4 or 5 when dry. It is silty clay loam or silt loam. The Bk horizon has value of 4 or 5 (5 or 6 when dry). The 2C horizon has value of 4 or 5 (5 or 6 when dry) and chroma of 3 or 4. It is loam or clay loam.

LaDelle Series

The LaDelle series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of LaDelle silty clay loam, 505 feet east and 630 feet south of the northwest corner of sec. 33, T. 140 N., R. 58 W.

A1—0 to 4 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate coarse and medium granular structure; hard, very friable, slightly sticky and plastic; common very fine and fine roots; common fine and very fine and many medium pores; slightly effervescent; mildly alkaline; clear smooth boundary.

A2—4 to 11 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; strong fine and very fine subangular blocky structure; hard, friable, sticky and plastic; few medium and common very fine and fine roots; few medium and common very fine and fine pores; strongly effervescent; mildly alkaline; clear smooth boundary.

Bw—11 to 17 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; moderate medium blocky structure; hard, friable, slightly sticky and plastic; few medium and very fine and common fine roots; few medium and common very fine and fine pores; slightly effervescent; moderately alkaline; clear smooth boundary.

Ab—17 to 30 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate fine granular; hard, friable, slightly sticky and slightly plastic; few medium and common fine and very fine roots; few medium and common fine and very fine pores; slightly effervescent; moderately alkaline; gradual wavy boundary.

C—30 to 60 inches; very dark grayish brown (2.5Y 3/2) stratified silty clay loam and silt loam, grayish brown (2.5Y 5/2) dry; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; few fine and common very fine pores; thin strata of dark grayish brown (10YR 4/2); strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 30 to 50 inches. The A horizon has value of 3 to 5 when dry. The Bw horizon has value of 2 or 3 (4 or 5 when dry). The C horizon has hue of 10YR or 2.5Y, value of 2 or 3 (4 or 5 when dry), and chroma of 1 to 3.

Lamoure Series

The Lamoure series consists of deep, poorly drained, moderately permeable soils on flood plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Lamoure silt loam, channeled, 165 feet north and 1,990 feet west of the southeast corner of sec. 26, T. 142 N., R. 56 W.

A1—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

A2—7 to 16 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; few masses of salts; slightly effervescent; moderately alkaline; abrupt wavy boundary.

A3—16 to 24 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; hard, friable, sticky and plastic; weak medium and fine subangular blocky structure; few very fine and fine roots; few fine pores; strongly effervescent; moderately alkaline; gradual wavy boundary.

A4—24 to 40 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak medium and fine subangular blocky structure; hard, friable, sticky and plastic; few very fine and fine roots; few fine pores; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1—40 to 55 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; few fine distinct olive brown (2.5Y 4/4) mottles; massive; hard, friable, sticky and plastic; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—55 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; few fine distinct olive brown (2.5Y 4/4) mottles; massive;

hard, friable, sticky and plastic; violently effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 40 inches. The C horizon has hue of 2.5Y or 5Y, value of 3 to 5 (6 or 7 when dry), and chroma of 1 or 2. It is silty clay loam or silt loam within a depth of 40 inches and loam, silt loam, silty clay loam, loamy coarse sand, coarse sandy loam, or loamy sand below that depth.

Lanona Series

The Lanona series consists of deep, well drained soils on lake plains. These soils formed in glaciolacustrine deposits and glacial till. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 0 to 9 percent.

Typical pedon of Lanona fine sandy loam, in an area of Lanona-Swenoda fine sandy loams, 2 to 6 percent slopes; 130 feet east and 150 feet south of the northwest corner of sec. 4, T. 140 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores; neutral; abrupt smooth boundary.

Bw1—8 to 12 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; common fine and very fine pores; neutral; clear smooth boundary.

Bw2—12 to 28 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; common fine and very fine pores; mildly alkaline; gradual wavy boundary.

2Bk—28 to 42 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few fine and very fine pores; common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

2C—42 to 60 inches; light olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) dry; few fine distinct gray (10YR 5/1) and yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 12 inches. The depth to the 2B horizon ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 or 4 when dry). It has chroma of 1 in the upper part and 1 or 2 in the lower part. The Bw horizon has value of 2 to 5 (4 to 6 when dry) and chroma of 1 to 4. Some pedons have a 2Bw horizon. The 2Bk horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 or 7 when dry), and chroma of 2 to 4. It is loam or silt loam. The 2C horizon has hue of 2.5Y or 5Y and value of 4 to 6 (6 or 7 when dry). It is loam or clay loam. It does not have mottles in some pedons.

Lismore Series

The Lismore series consists of deep, moderately well drained, moderately slowly permeable soils on till plains. These soils formed in glaciolacustrine deposits and glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Lismore silty clay loam, in an area of Lismore-Kranzburg silty clay loams, 0 to 2 percent slopes; 1,515 feet north and 285 feet west of the southeast corner of sec. 12, T. 137 N., R. 57 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

A—7 to 11 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to moderate fine granular; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; neutral; clear smooth boundary.

Bw1—11 to 20 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate fine subangular blocky; hard, friable, sticky and plastic; common very fine roots; common black (10YR 2/1) coatings on faces of peds; about 3 percent gravel; neutral; clear smooth boundary.

2Bw2—20 to 32 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; hard, friable, sticky

and plastic; common very fine roots; few very dark brown (10YR 2/2) coatings on faces of peds; about 3 percent gravel; neutral; clear wavy boundary.

2Bw3—32 to 40 inches; light olive brown (2.5Y 5/4) clay loam, light yellowish brown (2.5Y 6/4) dry; common medium faint grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; about 5 percent gravel; slightly effervescent; mildly alkaline; gradual wavy boundary.

2C—40 to 60 inches; light olive brown (2.5Y 5/4) clay loam, light yellowish brown (2.5Y 6/4) dry; common medium distinct gray (5Y 6/1) and few fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable, sticky and plastic; about 5 percent gravel; strongly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 16 to 25 inches. The A horizon has value of 2 or 3 (3 or 4 when dry). The Bw horizon is clay loam, loam, silt loam, or silty clay loam. Some pedons have a BC horizon. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It is clay loam or loam.

Manfred Series

The Manfred series consists of deep, very poorly drained, slowly permeable, alkali soils in outwash channels. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Manfred silt loam, in an area of Manfred and Vallers soils, extremely stony; 160 feet east and 1,020 feet south of the northwest corner of sec. 10, T. 137 N., R. 59 W.

A—0 to 5 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak thin platy structure; soft, friable, slightly sticky and slightly plastic; many very fine and common fine roots; common very fine pores; slightly acid; abrupt irregular boundary.

Btg1—5 to 9 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; moderate medium columnar structure parting to strong fine blocky; extremely hard, firm, very sticky and very plastic; few fine and common very fine roots; few fine and very fine pores; few faint clay films on faces of peds; moderately alkaline; clear wavy boundary.

Btg2—9 to 13 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; moderate medium prismatic structure parting to strong fine blocky; extremely hard, firm, very sticky and very plastic; common very fine roots; few faint clay films on faces of peds; common very fine pores; moderately alkaline; gradual wavy boundary.

Bkzg1—13 to 17 inches; olive gray (5Y 5/2) silty clay loam, light gray (5Y 7/2) dry; common fine faint yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; few fine and very fine roots; few very fine pores; vertical tongues of A horizon material throughout; common masses of salts; common soft masses of lime; violently effervescent; strongly alkaline; gradual wavy boundary.

Bkzg2—17 to 22 inches; olive gray (5Y 5/2) clay loam, gray (5Y 6/1) dry; common fine distinct yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; hard, friable, sticky and plastic; many masses of salts; many soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

Bkg—22 to 36 inches; olive gray (5Y 5/2) clay loam, gray (5Y 6/1) dry; many medium distinct yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; hard, friable, sticky and plastic; common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

Cg1—36 to 48 inches; light olive gray (5Y 6/2) clay loam, light gray (5Y 7/1) dry; many large prominent yellowish red (5YR 5/8) mottles; massive; hard, friable, sticky and plastic; about 5 percent coarse fragments; strongly effervescent; moderately alkaline; gradual wavy boundary.

Cg2—48 to 60 inches; olive gray (5Y 4/2) loam, light gray (5Y 7/2) dry; many large prominent yellowish red (5YR 5/8) mottles; massive; hard, friable, sticky and plastic; about 15 percent gravel; slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to gypsum or salts ranges from 10 to 16 inches.

The A horizon has hue of 10YR, or it is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. Some pedons have an E horizon 1 to 3 inches thick. The Btg horizon has hue of 2.5Y or 5Y, value of 2 or 3 (3 or 4 when dry), and chroma of 1 or 2. The Bkg horizon has hue of 2.5Y or 5Y and value of 4 to 6 (5 to 7 when dry). The C horizon has hue of 2.5Y or 5Y and value of 5 to 7 when dry.

Marysland Series

The Marysland series consists of deep, poorly drained, highly calcareous soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope is 0 to 1 percent.

Typical pedon of Marysland loam, 1,160 feet west and 300 feet south of the northeast corner of sec. 2, T. 142 N., R. 56 W.

A—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine and very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine, fine, and medium pores; strongly effervescent; moderately alkaline; clear wavy boundary.

Ak—8 to 18 inches; black (N 2/0) loam, dark gray (N 4/0) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine pores; disseminated lime throughout; violently effervescent; moderately alkaline; clear wavy boundary.

Bky—18 to 24 inches; very dark gray (N 3/0) loam, dark gray (N 4/0) dry; few fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine pores; common masses of gypsum; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Ab—24 to 30 inches; very dark brown (10YR 2/2) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and plastic; very slightly effervescent; moderately alkaline; gradual wavy boundary.

C—30 to 34 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; common medium prominent yellowish brown (10YR 5/8) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; slightly effervescent; moderately alkaline; clear smooth boundary.

2C—34 to 60 inches; dark grayish brown (2.5Y 4/2) gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; massive; loose, slightly sticky and nonplastic; about 20 percent gravel; very slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 30 inches. The A horizon has hue of 10YR or 2.5Y, or it is neutral in hue. It has value of 2 or 3. Some pedons do not have an Ak horizon. The Bky horizon has hue of 2.5Y, or it is neutral in hue. It has value of 3 or 4 and chroma of 0 or 1. The 2C horizon has hue of 2.5Y or 5Y, value of 3 or 4, and chroma of 1 or 2. The content of gravel in this horizon is 20 to 40 percent.

Nahon Series

The Nahon series consists of deep, moderately well drained, very slowly permeable, alkali soils on lake plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Nahon silt loam, in an area of Overly-Nahon silt loams; 330 feet north and 110 feet west of the southeast corner of sec. 15, T. 139 N., R. 58 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine pores; neutral; abrupt smooth boundary.

Bt1—7 to 11 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; strong medium columnar structure parting to moderate medium and fine subangular blocky; extremely hard, friable, sticky and plastic; common very fine roots; common very fine pores; few faint clay films on faces of peds; many black (10YR 2/1) coatings on faces of peds; mildly alkaline; clear smooth boundary.

Bt2—11 to 17 inches; very dark grayish brown (10YR 3/2) silty clay, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to strong medium subangular blocky; extremely hard, firm, sticky and plastic; few very fine roots; few very fine pores; common distinct clay films on faces of peds; many black (10YR 2/1) coatings on faces of peds; mildly alkaline; gradual wavy boundary.

Bkz1—17 to 21 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; weak medium prismatic structure parting to weak medium and fine subangular blocky; hard, friable, sticky and plastic; few very fine roots; few very fine pores; common masses of salts; common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

Bkz2—21 to 28 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; weak medium and fine subangular blocky structure; hard, friable, sticky and plastic; common masses of salts;

common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk—28 to 38 inches; light olive brown (2.5Y 5/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

C1—38 to 46 inches; light olive brown (2.5Y 5/4) very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; common fine faint yellowish brown (10YR 5/6) mottles; massive; hard, very friable, nonsticky and nonplastic; slightly effervescent; moderately alkaline; clear smooth boundary.

C2—46 to 60 inches; light olive brown (2.5Y 5/4) stratified very fine sandy loam and silt loam, light yellowish brown (2.5Y 6/4) dry; massive; hard, very friable, sticky and plastic; slightly effervescent; moderately alkaline.

The depth to carbonates ranges from 15 to 24 inches. The A horizon has value of 2 or 3 (3 or 4 when dry). Undisturbed pedons have an E horizon 1 to 3 inches thick. The Bt horizon has value of 2 or 3 (3 or 4 when dry). Some pedons have a Bty or Btz horizon. The Bk horizon has value of 3 to 5. Some pedons have a Bky horizon. The C horizon has value of 4 to 7 (6 to 8 when dry) and chroma of 2 to 4. It is loam, very fine sandy loam, or silt loam.

Nutley Series

The Nutley series consists of deep, well drained, slowly permeable soils in stream valleys. These soils formed in colluvium. Slope ranges from 0 to 15 percent.

Typical pedon of Nutley silty clay, 2 to 6 percent slopes, 2,475 feet east and 2,440 feet south of the northwest corner of sec. 3, T. 139 N., R. 58 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; hard, firm, very sticky and very plastic; many very fine and fine roots; many very fine and fine pores; slightly effervescent; moderately alkaline; abrupt smooth boundary.

Bw1—8 to 15 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to strong very fine subangular blocky; hard, firm, very sticky and very plastic; common very fine and fine roots; common very fine and fine pores; vertical tongues of A horizon material throughout; slightly effervescent; mildly alkaline; clear smooth boundary.

Bw2—15 to 23 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to strong very fine subangular blocky; hard, firm, very sticky and very plastic; common very fine and fine roots; common very fine and fine pores; strongly effervescent; mildly alkaline; gradual wavy boundary.

Bk—23 to 29 inches; dark grayish brown (2.5Y 4/2) clay, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to moderate very fine and fine subangular blocky; very hard, firm, very sticky and very plastic; few very fine and fine roots; few very fine and fine pores; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Bky—29 to 36 inches; dark grayish brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; very hard, firm, very sticky and very plastic; common masses of gypsum; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Cy1—36 to 52 inches; grayish brown (2.5Y 5/2) clay, light brownish gray (2.5Y 6/2) dry; massive; very hard, firm, very sticky and very plastic; common masses of gypsum; strongly effervescent; moderately alkaline; gradual wavy boundary.

Cy2—52 to 60 inches; olive gray (5Y 4/2) clay, light olive gray (5Y 6/2) dry; few fine prominent strong brown (7.5YR 5/6) mottles; massive; very hard, firm, very sticky and very plastic; few masses of gypsum; slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 when dry) and chroma of 1 or 2. The Bw horizon has hue of 10YR to 5Y, value of 3 to 5 (4 to 6 when dry), and chroma of 1 or 2. The Cy horizon has value of 4 to 6 (5 to 7 when dry) and chroma of 2 or 3.

Overly Series

The Overly series consists of deep, moderately well drained, moderately slowly permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Overly silty clay loam, in an area of

Overly-Bearden silty clay loams; 985 feet north and 1,320 feet west of the southeast corner of sec. 26, T. 140 N., R. 58 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; neutral; abrupt smooth boundary.

Bw—8 to 17 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate coarse and medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, friable, sticky and plastic; neutral; clear smooth boundary.

Bk1—17 to 25 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; weak coarse and medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky and plastic; common soft masses of lime; violently effervescent; mildly alkaline; gradual wavy boundary.

Bk2—25 to 31 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; few fine faint light yellowish brown (2.5Y 6/4) mottles; moderate medium and fine subangular blocky structure; hard, friable, sticky and plastic; common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk3—31 to 37 inches; light olive brown (2.5Y 5/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; few fine olive yellow (2.5Y 6/6) mottles; weak coarse and medium subangular blocky structure; hard, friable, sticky and plastic; common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

Cy1—37 to 46 inches; light olive brown (2.5Y 5/4) silty clay loam, pale olive (5Y 6/3) dry; common fine prominent yellowish brown (10YR 5/4) mottles; massive; hard, friable, sticky and plastic; many masses of gypsum; slightly effervescent; moderately alkaline; gradual wavy boundary.

Cy2—46 to 55 inches; light olive brown (2.5Y 5/4) silty clay loam, pale olive (5Y 6/3) dry; common fine prominent yellowish brown (10YR 5/6) mottles; massive; hard, friable, sticky and plastic; few masses of gypsum; slightly effervescent; moderately alkaline; gradual wavy boundary.

2C—55 to 60 inches; light brownish gray (2.5Y 6/2) very fine sandy loam, light gray (2.5Y 7/2) dry; many large prominent yellowish brown (10YR 5/8) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; very slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The A and Bk horizons are silt loam or silty clay loam. The A horizon has value of 3 or 4 when dry. The C horizon is silt loam or silty clay loam within a depth of 40 inches and ranges from very fine sandy loam to silty clay below that depth.

Parnell Series

The Parnell series consists of deep, very poorly drained, slowly permeable soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Parnell silty clay loam, 1,350 feet west and 1,000 feet north of the southeast corner of sec. 34, T. 143 N., R. 56 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; many very fine and few fine roots; many very fine pores; mildly alkaline; abrupt smooth boundary.

Bt1—8 to 15 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine angular blocky structure; hard, firm, sticky and plastic; common very fine roots; many very fine pores; few faint clay films on faces of peds; mildly alkaline; gradual smooth boundary.

Bt2—15 to 35 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate very fine angular blocky structure; hard, firm, sticky and plastic; few very fine roots; common very fine pores; few faint clay films on faces of peds; mildly alkaline; gradual smooth boundary.

Cg1—35 to 42 inches; olive gray (5Y 5/2) silty clay loam, light gray (5Y 7/2) dry; common medium prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine pores; moderately alkaline; gradual smooth boundary.

Cg2—42 to 60 inches; gray (5Y 5/1) clay loam, light gray (5Y 7/1) dry; common medium prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable, sticky and plastic; slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 34 to 41 inches. The A horizon has value of 2 or 3 (3 or 4

when dry). The Bt horizon has value of 3 to 5 when dry. It is silty clay loam or silty clay. The Cg horizon has hue of 2.5Y or 5Y and value of 5 or 6 (5 to 7 when dry).

Renshaw Series

The Renshaw series consists of deep, somewhat excessively drained soils on outwash plains and terraces. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope ranges from 0 to 25 percent.

Typical pedon of Renshaw loam, 0 to 2 percent slopes, 1,230 feet south and 200 feet east of the northwest corner of sec. 1, T. 142 N., R. 56 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many very fine roots; many very fine pores; mildly alkaline; abrupt smooth boundary.

Bw—8 to 16 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to moderate coarse and medium subangular blocky; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; common very fine pores; mildly alkaline; gradual wavy boundary.

2C1—16 to 21 inches; dark brown (10YR 4/3) gravelly coarse sand, brown (10YR 5/3) dry; single grain; soft, very friable, nonsticky and nonplastic; about 20 percent gravel; pebbles coated with calcium carbonates; strongly effervescent; moderately alkaline; diffuse wavy boundary.

2C2—21 to 60 inches; grayish brown (10YR 5/2) gravelly coarse sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; about 30 percent gravel; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 10 to 16 inches. The depth to sand and gravel ranges from 14 to 20 inches.

The A horizon has value of 2 or 3 (3 or 4 when dry). The Bw horizon has value of 3 or 4 (4 or 5 when dry) and chroma of 1 or 2. It is loam or gravelly loam. Some pedons have a 2Bk horizon 2 to 5 inches thick. The 2C horizon has hue of 7.5YR to 2.5Y, value of 2 to 6, and chroma of 2 to 4. It is gravelly coarse sand, very gravelly sand, or loamy coarse sand.

Sinai Series

The Sinai series consists of deep, well drained, slowly permeable soils in stream valleys. These soils formed in alluvium and colluvium. Slope ranges from 0 to 6 percent.

Typical pedon of Sinai silty clay loam, 0 to 2 percent slopes, 1,500 feet west and 1,000 feet south of the northeast corner of sec. 28, T. 139 N., R. 58 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; hard, friable, sticky and plastic; few common and many fine and very fine roots; few fine and very fine pores; neutral; abrupt smooth boundary.

Bw—9 to 18 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium prismatic structure parting to moderate medium and fine angular blocky; hard, friable, sticky and plastic; few fine and common very fine pores; neutral; gradual wavy boundary.

Bk1—18 to 23 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium and fine angular blocky; very hard, friable, sticky and plastic; few fine and medium roots; few fine pores; vertical tongues of A horizon material throughout; few fine soft masses of lime; violently effervescent; mildly alkaline; gradual wavy boundary.

Bk2—23 to 32 inches; dark grayish brown (10YR 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; weak medium and fine angular blocky structure; very hard, friable, sticky and plastic; vertical tongues of A horizon material throughout; many fine and medium soft masses of lime; violently effervescent; mildly alkaline; gradual wavy boundary.

Bk3—32 to 43 inches; olive gray (5Y 5/2) silty clay, light olive gray (5Y 6/2) dry; moderate medium angular blocky structure; hard, firm, sticky and plastic; few fine and medium soft masses of lime; violently effervescent; mildly alkaline; gradual wavy boundary.

BC—43 to 49 inches; olive gray (5Y 5/2) silty clay, light olive gray (5Y 6/2) dry; common large prominent yellowish brown (10YR 5/4) mottles; massive; very hard, firm, sticky and plastic; many medium and few large soft masses of lime; violently effervescent; mildly alkaline; gradual wavy boundary.

C—49 to 60 inches; olive gray (5Y 5/2) silty clay, pale olive (5Y 6/3) dry; common large distinct yellowish brown (10YR 5/4) mottles; massive; very hard, firm, sticky and plastic; violently effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 16 to 25 inches. The A horizon has value of 2 or 3 (3 or 4 when dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 6 when dry), and chroma of 1 or 2. It is silty clay loam or silty clay. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 or 6 when dry), and chroma of 1 to 3. It is silt loam, silty clay loam, or silty clay.

Sioux Series

The Sioux series consists of deep, excessively drained, rapidly permeable soils on outwash plains, kames, eskers, and terraces. These soils formed in glaciofluvial deposits (fig. 10). Slope ranges from 1 to 25 percent.

Typical pedon of Sioux loam, in an area of Renshaw-Sioux loams, 2 to 9 percent slopes; 1,300 feet east and 1,500 feet south of the northwest corner of sec. 27, T. 139 N., R. 58 W.

A—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores; about 5 percent gravel; neutral; clear smooth boundary.

AC—6 to 8 inches; very dark grayish brown (10YR 3/2) gravelly loam, dark brown (10YR 4/3) dry; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and common fine roots; many very fine and common fine pores; about 25 percent gravel; slightly effervescent; moderately alkaline; abrupt smooth boundary.

2C1—8 to 16 inches; dark brown (10YR 4/3) very gravelly coarse sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; common very fine and few fine roots; common very fine and few fine pores; about 40 percent gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

2C2—16 to 60 inches; dark brown (10YR 4/3) and grayish brown (10YR 5/2) extremely gravelly coarse sand, brown (10YR 5/3) and light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; about 65 percent gravel; few very fine roots; few very fine pores; strongly effervescent; moderately alkaline.

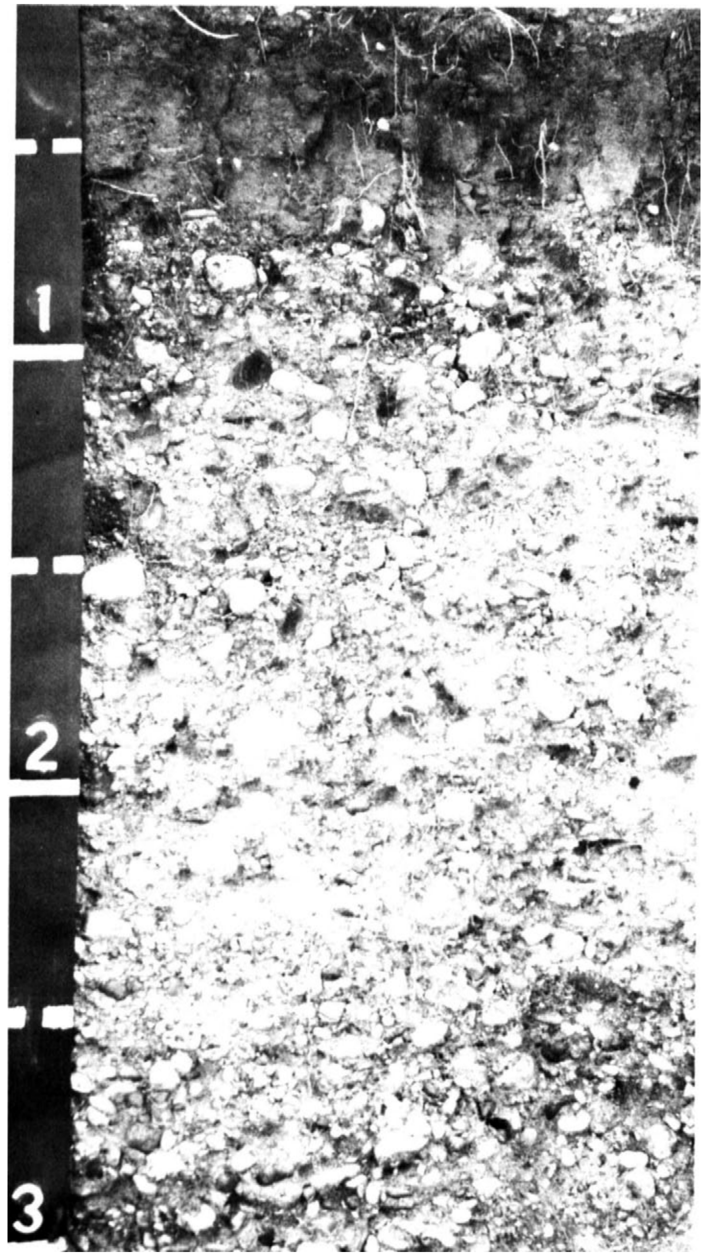

Figure 10.—Profile of a Sioux soil, which has sand and gravel below a depth of 8 inches. Depth is marked in feet.

The thickness of the mollic epipedon ranges from 7 to 10 inches. The depth to sand and gravel ranges from 6 to 14 inches.

The A horizon has value of 2 to 3 (3 to 5 when dry). The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 when dry, and chroma of 2 to 4.

Southam Series

The Southam series consists of deep, very poorly drained, slowly permeable soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Southam silty clay loam, 135 feet east and 1,500 feet south of the northwest corner of sec. 14, T. 138 N., R. 61 W.

Oi—2 inches to 0; very dark brown (10YR 2/2), mostly undecomposed leaves and stems, very dark grayish brown (10YR 3/2) dry; many very fine and fine and common medium roots; slightly acid.

A1—0 to 14 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and very fine granular structure; hard, friable, sticky and plastic; many very fine, common fine, and few medium roots; many very fine and common fine pores; common fine snail shell fragments; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

A2—14 to 24 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; common fine prominent light olive brown (2.5Y 5/4) mottles; weak fine and very fine subangular blocky structure; hard, firm, sticky and plastic; common very fine and few fine roots; few very fine pores; common fine snail shell fragments; disseminated lime throughout; violently effervescent; mildly alkaline; gradual wavy boundary.

A3—24 to 29 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; common fine prominent light olive brown (2.5Y 5/4) mottles; weak medium and fine subangular structure; hard, very firm, very sticky and very plastic; few very fine roots; few very fine pores; common fine snail shell fragments; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Cg1—29 to 36 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; many medium distinct olive (5Y 5/4) mottles; massive; hard, firm, very sticky and very plastic; few very fine roots; few very fine pores; few fine snail shell fragments; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Cg2—36 to 49 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; many medium distinct olive (5Y 5/4) mottles; massive; hard, firm, very sticky and very plastic; common threads of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

2Cg3—49 to 60 inches; dark olive gray (5Y 3/2) loam, gray (5Y 5/1) dry; few fine distinct olive (5Y 5/4) mottles; massive; hard, firm, sticky and plastic; disseminated lime throughout; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 60 inches. The thickness of the O horizon ranges from 1 to 4 inches.

The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 to 5 when dry). The Cg horizon has hue of 2.5Y or 5Y and value of 3 to 5 (5 to 7 when dry). It is silty clay or silty clay loam within a depth of 40 inches and loam, clay loam, silty clay loam, or silty clay below that depth.

Svea Series

The Svea series consists of deep, moderately well drained, moderately slowly permeable soils on till plains (fig. 11). These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Svea loam, in an area of Svea-Barnes loams, 0 to 2 percent slopes; 1,335 feet west and 920 feet north of the southeast corner of sec. 31, T. 139 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; neutral; abrupt smooth boundary.

A—8 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; neutral; clear smooth boundary.

Bw1—12 to 16 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine pores; mildly alkaline; gradual wavy boundary.

Bw2—16 to 20 inches; very dark grayish brown (10YR

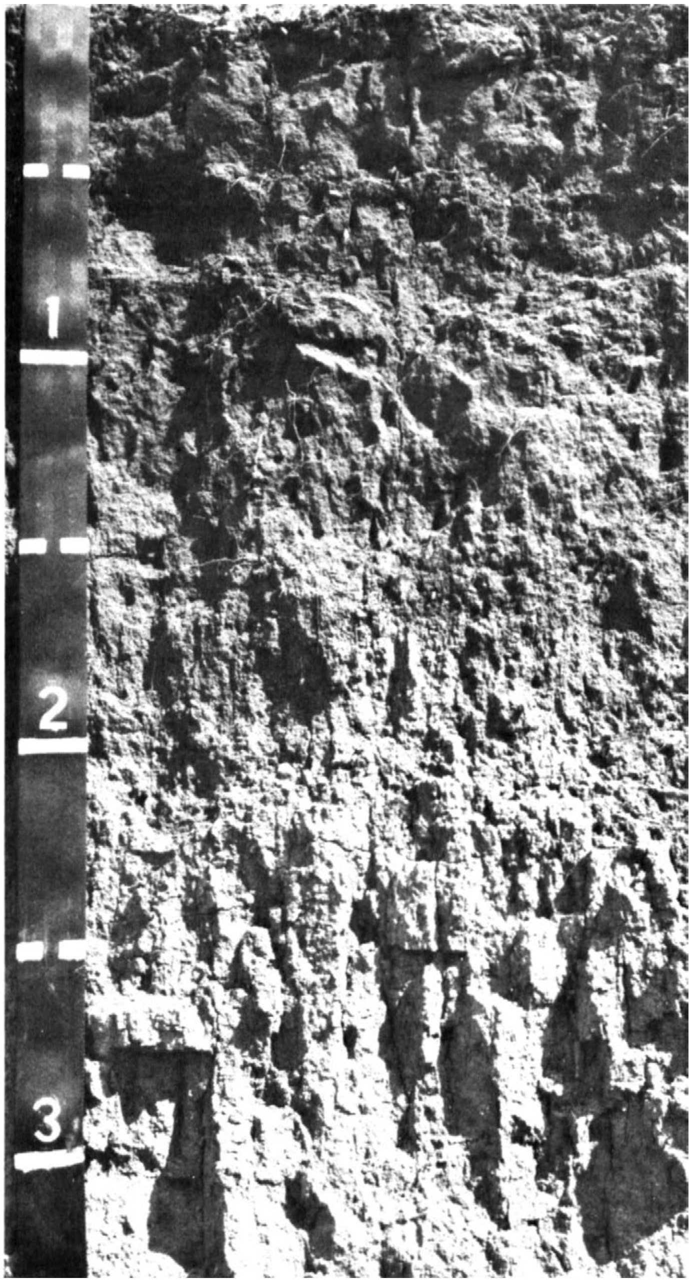

Figure 11.—Profile of a Svea soil. Below a depth of 25 inches, the subsoil has accumulated lime leached from the layers above. Depth is marked in feet.

3/2) loam, grayish brown (10YR 5/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine pores; mildly alkaline; gradual wavy boundary.

Bw3—20 to 25 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; weak medium prismatic structure parting to moderate medium blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine pores; mildly alkaline; gradual wavy boundary.

Bk1—25 to 35 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine pores; common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk2—35 to 43 inches; light brownish gray (2.5Y 6/2) loam, light gray (2.5Y 7/2) dry; common fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

C—43 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; disseminated lime throughout; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 26 inches. The A horizon has value of 2 or 3 (3 to 5 when dry). The Bw horizon has value of 2 to 4 (3 to 5 when dry) and chroma of 1 to 3. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 when dry), and chroma of 1 to 4. Some pedons have a BC or BCk horizon. The C horizon has value of 4 or 5 (5 or 6 when dry) and chroma of 2 to 4.

Swenoda Series

The Swenoda series consists of deep, moderately well drained soils on lake plains. These soils formed in glaciolacustrine deposits and glacial till. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 0 to 6 percent.

Typical pedon of Swenoda fine sandy loam, in an area of Lanona-Swenoda fine sandy loams, 2 to 6 percent slopes; 215 feet east and 130 feet south of the northwest corner of sec. 4, T. 140 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores; neutral; abrupt smooth boundary.

Bw1—8 to 18 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; common fine and very fine pores; neutral; clear smooth boundary.

Bw2—18 to 34 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine and common very fine roots; few fine and common very fine pores; neutral; clear smooth boundary.

2Bk—34 to 42 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to weak fine subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine roots; few fine and common very fine pores; disseminated lime throughout; slightly effervescent; mildly alkaline; clear smooth boundary.

2BCk—42 to 50 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; common medium distinct gray (5Y 6/1) and few fine prominent yellowish brown (10YR 5/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; common soft masses of lime; violently effervescent; moderately alkaline; gradual smooth boundary.

2C—50 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; common medium distinct gray (10YR 5/1) and few fine prominent yellowish brown (10YR 5/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 28 inches. The depth to the 2Bk horizon ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 or 4 when dry). The Bw horizon has value of 2 to 4 and chroma of 1 to 3. Some pedons have a 2Bw horizon. The 2Bk horizon has value of 4 to 6 (6 or 7 when dry) and chroma of 2 to 4. It is loam or silt loam. Some pedons have a Bk or 2BC horizon. The 2C horizon has value of 4 to 6 (6 or 7 when dry). It is loam or silt loam. It is not mottled in some pedons.

Tonka Series

The Tonka series consists of deep, poorly drained, slowly permeable soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Tonka silt loam, 2,370 feet south and 1,400 feet west of the northeast corner of sec. 24, T. 139 N., R. 56 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine and few medium and large roots; many very fine and fine pores; mildly alkaline; abrupt smooth boundary.

A—9 to 13 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak coarse and medium subangular blocky structure parting to weak thin platy; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine and few medium and large roots; many very fine and fine pores; mildly alkaline; gradual wavy boundary.

E—13 to 18 inches; dark grayish brown (10YR 4/2) silt loam, gray (10YR 6/1) dry; many medium distinct yellowish brown (10YR 5/8) mottles; weak coarse and medium subangular blocky structure parting to moderate thin platy; slightly hard, very friable, nonsticky and nonplastic; common very fine, fine, medium, and large roots; common very fine and fine pores; neutral; gradual wavy boundary.

Bt—18 to 27 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to strong fine angular blocky; hard, firm, sticky and plastic; few very fine, fine, medium, and large roots; few very fine and fine pores; few distinct clay films on faces of peds; mildly alkaline; gradual wavy boundary.

Btg—27 to 34 inches; olive gray (5Y 4/2) clay, olive gray (5Y 5/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to strong fine angular blocky; hard, firm, sticky and plastic; few very fine, fine, medium, and large roots; few very fine and fine pores; common prominent clay films on faces of peds; mildly alkaline; gradual wavy boundary.

Bw—34 to 39 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; few fine and many medium prominent yellowish brown (10YR 5/8) mottles; moderate medium and fine

subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine, fine, medium, and large roots; few very fine and fine pores; mildly alkaline; gradual wavy boundary.

Cg—39 to 60 inches; olive gray (5Y 5/2) silt loam, light gray (5Y 7/2) dry; massive; hard, firm, nonsticky and nonplastic; strongly effervescent; moderately alkaline.

The A horizon has value of 2 or 3 (3 to 5 when dry). The E horizon has value of 3 or 4 (4 to 6 when dry). The Bt horizon has value of 2 to 4 (4 to 7 when dry) and chroma of 1 or 2. It is silty clay loam, clay, or clay loam. The Cg horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 7 when dry), and chroma of 1 or 2. It is silty clay loam, clay loam, silt loam, sandy clay loam, or loam. Some pedons have 2 to 10 percent gravel in the Cg horizon.

Vallers Series

The Vallers series consists of deep, poorly drained, moderately slowly permeable, highly calcareous soils on till plains and in outwash channels. These soils formed in glacial till and alluvium. Slope is 0 to 1 percent.

Typical pedon of Vallers loam, in an area of Vallers-Parnell complex; 200 feet west and 345 feet north of the southeast corner of sec. 14, T. 140 N., R. 56 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; strongly effervescent; moderately alkaline; abrupt smooth boundary.

Bk—7 to 13 inches; dark gray (10YR 4/1) loam, gray (10YR 6/1) dry; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; about 2 percent gravel; disseminated lime throughout; violently effervescent; moderately alkaline; clear wavy boundary.

Bkyg—13 to 18 inches; light olive gray (5Y 6/2) loam, white (5Y 8/1) dry; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine pores; about 2 percent gravel; few small masses of gypsum; disseminated lime throughout; strongly effervescent; moderately alkaline; gradual wavy boundary.

Byg—18 to 32 inches; olive gray (5Y 4/2) loam, light olive gray (5Y 6/2) dry; few fine prominent dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) mottles; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; about 2 percent gravel; many medium masses of gypsum; very slightly effervescent; moderately alkaline; gradual wavy boundary.

Cg—32 to 60 inches; dark gray (5Y 4/1) loam, gray (5Y 6/1) dry; many large prominent yellowish brown (10YR 5/8) mottles; massive; hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 15 inches. The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (4 or 5 when dry). Some pedons have an ABk horizon. The Bk horizon has value of 3 to 6 (5 to 8 when dry). It is loam or clay loam. The Byg horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 to 8 when dry), and chroma of 1 or 2. Some pedons have a BCk or BC horizon. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6 (4 to 7 when dry), and chroma of 1 to 3. It is loam or clay loam.

Wyard Series

The Wyard series consists of deep, somewhat poorly drained, moderately permeable soils on till plains. The soils formed in alluvium and glacial till. The slope is 0 to 1 percent.

Typical pedon of Wyard loam, in an area of Hamerly-Wyard loams, 0 to 3 percent slopes; 1,335 feet east and 265 feet north of the southwest corner of sec. 32, T. 142 N., R. 60 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; neutral; abrupt smooth boundary.

A1—7 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to moderate medium granular; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine pores; neutral; clear smooth boundary.

A2—12 to 23 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; common medium distinct light yellowish brown (2.5Y 6/4) mottles in the lower part; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard,

friable, slightly sticky and slightly plastic; common very fine roots; common very fine pores; few patches of clean sand and silt grains on faces of peds; neutral; clear wavy boundary.

Bw—23 to 30 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; few medium distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; few fine black iron and manganese concretions; cracks filled with A horizon material extending into this horizon; neutral; gradual smooth boundary.

Bk—30 to 41 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine pores; lime disseminated throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

C—41 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; many large distinct light olive gray and common medium prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine pores; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 24 inches. The A and Bw horizons are loam or silt loam. The A horizon has value of 2 or 3 (3 or 4 when dry). The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 to 6 when dry), and chroma of 2 to 4. The Bk and C horizons are loam and clay loam. The Bk horizon has value of 4 or 5 (5 to 7 when dry) and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 when dry), and chroma of 2 to 4.

Zell Series

The Zell series consists of deep, well drained, moderately permeable soils on lake plains. These soils formed in glaciolacustrine deposits. Slope ranges from 3 to 25 percent.

Typical pedon of Zell silt loam, 9 to 25 percent slopes, 250 feet south and 935 feet west of the northeast corner of sec. 33, T. 141 N., R. 58 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many fine and very fine and few medium roots; many fine and very fine and few medium pores; disseminated lime throughout; strongly effervescent; moderately alkaline; abrupt smooth boundary.

Bk1—8 to 12 inches; light olive brown (2.5Y 5/4) silt loam, light brownish gray (2.5Y 6/2) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine and fine and few medium pores; disseminated lime throughout; violently effervescent; moderately alkaline; clear wavy boundary.

Bk2—12 to 23 inches; light olive brown (2.5Y 5/4) silt loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine and few fine pores; common fine masses of lime; violently effervescent; moderately alkaline; clear wavy boundary.

BCk—23 to 34 inches; light olive brown (2.5Y 5/4) very fine sandy loam, pale yellow (2.5Y 7/4) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

C1—34 to 44 inches; light olive brown (2.5Y 5/4) very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; disseminated lime throughout; strongly effervescent; moderately alkaline; gradual smooth boundary.

C2—44 to 60 inches; light olive brown (2.5Y 5/4) very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; disseminated lime throughout; slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 10 inches. The Ap horizon has value of 2 or 3 (3 or 4 when dry). The Bk horizon has hue of 10YR or 2.5Y and value of 4 or 5. The C horizon has value of 4 to 6 and chroma of 3 or 4. It is silt loam or very fine sandy loam.

Formation of the Soils

This section relates the factors of soil formation to the formation of the soils in Barnes County.

Soil is formed through processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rock and slowly change it to a natural body that has genetically related horizons. The effect of climate and plant and animal life is conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Usually a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

The soils in Barnes County formed in glacial drift. During the Pleistocene period, Barnes County was glaciated. It was overridden by the Des Moines ice lobe, which advanced generally from the northwest. The glacial activity picked up rocks and soil and ground and mixed them and deposited the material as the ice melted from the receding glacier.

Examples of some of the soils in the county and the material in which they formed are as follows: Barnes and Svea soils, unsorted material or glacial till; Gardena and Bearden soils, glaciolacustrine deposits; Renshaw and Sioux soils, glacial outwash deposits; LaDelle and Lamoure soils, postglacial alluvium on bottom lands of rivers and streams; and Nutley soils in the Sheyenne River Valley, colluvial deposits from outcrops of weathered shale along the valley walls.

Climate

Climate affects the physical, chemical, and biological characteristics of the soil. Rainfall, humidity, and frost influence the availability of moisture and the rate of percolation. The movement of water dissolves minerals and transports them in the soil mass. Temperature influences formation by regulating the growth of organisms and the speed of chemical reactions.

Barnes County has a cool, subhumid, continental climate characterized by wide variations in temperature from summer to winter. The winters are long, and the soil is generally frozen to a depth of 3 to 6 feet from November to April. During this time, except for some effects of frost action, the soil forming processes are mostly dormant. During the growing season the soil receives approximately 90 percent of the annual precipitation. It is during this part of the year that the soil forming processes influenced by climate are most active. The climate is essentially uniform throughout the county. Additional information on climate is given in the section "General Nature of the County."

Plant and Animal Life

The kind of vegetation in Barnes County is dependent mainly on the climate and relief. Grasses are the dominant vegetation. Native woodlands are in the Sheyenne River Valley and on some of the ravines and coulees leading to the valley.

On the somewhat poorly drained and moderately well drained, nearly level soils, such as Hamerly, Svea, Gardena, Glyndon, Bearden, Lismore, and Overly, the native vegetation is mainly tall and medium-size grasses. The principal grasses are big bluestem,

switchgrass, indiangrass, and little bluestem.

On the well drained and excessively drained, nearly level to steep soils, such as Sioux, Renshaw, Buse, Zell, and Kloten, medium-size and short grasses are dominant. Among these grasses are green needlegrass, western wheatgrass, little bluestem, sideoats grama, plains muhly, and blue grama.

On the poorly drained and very poorly drained, depressional soils, such as Arveson, Colvin, Tonka, Parnell, and Dovray, the vegetation consists of tall grasses, reeds, rivergrass, slough sedge, American mannagrass, northern reedgrass, and prairie cordgrass.

The activities of certain micro-organisms, such as bacteria and fungi, are important in soil formation in Barnes County. These micro-organisms break down undecomposed organic matter and change it to humus. Some bacteria take nitrogen from the air and change it into a form that can be used by plants. The activities of certain burrowing rodents, worms, and insects aid in the percolation of rainwater through the soil and cause some mixing of organic and inorganic materials.

The main effect of plant and animal life on soil formation is the accumulation of organic matter and the translocation of plant nutrients from the lower to the upper layers. Native grass has contributed large amounts of organic matter to the soils. The roots grow into the lower horizons, take up calcium, phosphorus, potassium, and other nutrients, and then leave these elements near the surface when the plants die and decay. The soils that have granular structure form in areas where calcium and a high content of organic matter are in the surface layer.

The activities of man, particularly in altering drainage, maintaining fertility, and changing the kinds of vegetation, have an important effect upon both the rate and direction of soil formation.

Relief

Most of Barnes County is nearly level to undulating, but some areas are rolling to steep. Many poorly drained and very poorly drained soils in depressions receive runoff from higher elevations. The steepest areas are the end moraines and the breaks of the Sheyenne River Valley. Local differences in relief within a square mile range from less than 10 feet to 50 to 150 feet.

Relief influences the formation of soil through its effect on drainage, runoff, and erosion. Many differences in the soils of this county result from their topographic position. Among these differences are drainage, thickness of the A horizon, content of organic matter, color and mottling of the subsoil, thickness of the solum, and degree of horizon differentiation.

Runoff is rapid on steep slopes, and only a small percentage of the rainfall penetrates the soil. Under these conditions, there is little moisture for plant growth and soil development. The steep soils are thin and low in organic matter content, and they have weak horizonation. Examples of these are Buse, Sioux, and Zell soils.

Soils on nearly level to rolling slopes are moderately well drained and well drained. Moisture is sufficient to support good stands of mixed native grasses, and the soils have well developed profiles characterized by a black to very dark gray A horizon and a brown to very dark brown B horizon. Examples of these are Barnes, Kranzburg, and Egeland soils. Most of the moderately well drained soils occur as level or slightly concave areas. They generally have a thicker A horizon, a darker colored B horizon, and a greater depth to lime than those on convex, undulating, or rolling landscapes. Examples of these are Gardena, Lismore, and Svea soils.

Depressional areas that receive large amounts of runoff from higher elevations have somewhat poor to very poor natural drainage. Most of the soils in these positions are characterized by a thick, black A horizon, a mottled gray or olive subsoil, and substrata similar to the subsoil. Examples of these are Parnell, Dovray, Tonka, and Southam soils.

Time

Time is necessary for the factors of soil formation to act on parent material. The length of time for a particular soil to develop depends on the kind of parent material and many other factors.

The degree of profile development in most of the soils in Barnes County has been more affected by other differences than by the length of time, because the length of time has been about the same for all of these soils. In terms of geological time, the soils are young because they formed from material deposited in late Pleistocene time, which ended about 11,000 years ago.

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Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Cover crop. A close-growing crop grown primarily to

improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads,

buildings and other structures, and plant roots.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are—

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-84 at Valley City, North Dakota)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	15.7	-5.1	5.3	44	-34	0	0.48	0.11	0.71	2	6.9
February----	23.5	2.4	13.0	49	-27	10	.43	.15	.64	2	4.8
March-------	34.9	13.9	24.4	63	-20	37	.75	.18	1.14	2	5.8
April-------	53.5	29.5	41.5	86	6	158	1.53	.46	2.36	4	3.1
May---------	68.3	41.0	54.7	91	21	462	2.27	1.03	3.20	6	.1
June--------	76.1	50.8	63.5	94	36	705	3.50	1.80	4.86	7	.0
July--------	82.9	56.2	69.6	97	40	918	2.71	1.17	3.95	5	.0
August------	81.5	53.4	67.5	100	37	853	2.22	.85	3.24	5	.0
September---	70.3	42.3	56.3	97	23	489	1.87	.63	2.86	4	.0
October-----	58.3	32.3	45.3	85	11	224	1.36	.32	2.09	3	.7
November----	37.9	17.7	27.8	67	-12	22	.65	.17	.94	2	4.2
December----	22.5	2.6	12.6	49	-31	10	.55	.25	.79	2	5.8
Yearly:											
Average---	52.1	28.5	40.1	---	---	---	---	---	---	---	---
Extreme---	---	---	---	101	-35	---	---	---	---	---	---
Total-----	---	---	---	---	---	3,888	18.32	14.71	21.85	44	31.4

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-84 at Valley City, North Dakota)

Probability	Temperature		
	24^{o} F or lower	28^{o} F or lower	32^{o} F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 15	May 22	June 5
2 years in 10 later than--	May 9	May 18	May 31
5 years in 10 later than--	Apr. 29	May 11	May 20
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 20	Sept. 9	Sept. 3
2 years in 10 earlier than--	Sept. 26	Sept. 14	Sept. 7
5 years in 10 earlier than--	Oct. 8	Sept. 25	Sept. 16

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-84 at Valley City, North Dakota)

Probability	Daily minimum temperature during growing season		
	Higher than 24^{o} F	Higher than 28^{o} F	Higher than 32^{o} F
	Days	Days	Days
9 years in 10	136	114	95
8 years in 10	145	122	103
5 years in 10	161	136	118
2 years in 10	178	151	133
1 year in 10	186	158	141

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
2	Tonka silt loam	3,330	0.3
3	Parnell silty clay loam	19,310	2.0
6	Southam silty clay loam	15,010	1.6
9	Nutley silty clay, 0 to 2 percent slopes	1,860	0.2
9B	Nutley silty clay, 2 to 6 percent slopes	3,740	0.4
9D	Nutley silty clay, 6 to 15 percent slopes	3,570	0.4
12	Lismore-Kranzburg silty clay loams, 0 to 2 percent slopes	9,650	1.0
13B	Kranzburg-Lismore silty clay loams, 2 to 6 percent slopes	8,880	0.9
14B	Barnes-Buse loams, 3 to 6 percent slopes	134,380	14.0
14C	Barnes-Buse loams, 6 to 9 percent slopes	50,460	5.3
14D	Barnes-Buse loams, 9 to 15 percent slopes	9,440	1.0
15	Swenoda-Lanona fine sandy loams, 0 to 2 percent slopes	2,570	0.3
15B	Lanona-Swenoda fine sandy loams, 2 to 6 percent slopes	4,100	0.4
15C	Lanona fine sandy loam, 6 to 9 percent slopes	1,240	0.1
16B	Barnes-Sioux loams, 1 to 6 percent slopes	8,250	0.9
16C	Barnes-Sioux loams, 6 to 9 percent slopes	7,740	0.8
16E	Barnes-Sioux loams, 9 to 25 percent slopes	3,900	0.4
17B	Barnes-Svea loams, 2 to 6 percent slopes	99,390	10.4
18	Bearden silty clay loam	2,620	0.3
19	Colvin silty clay loam, saline	5,380	0.6
23F	Buse-Barnes loams, 15 to 35 percent slopes	23,130	2.4
26	Colvin silty clay loam	4,660	0.5
27	Divide loam	13,100	1.4
31B	Egeland fine sandy loam, 1 to 6 percent slopes	2,050	0.2
36	Fargo silty clay	3,620	0.4
40B	Gardena-Zell silt loams, 3 to 6 percent slopes	4,570	0.5
40C	Zell silt loam, 6 to 9 percent slopes	1,200	0.1
40E	Zell silt loam, 9 to 25 percent slopes	1,070	0.1
43	Gardena silt loam	9,430	1.0
46	Gardena-Glyndon silt loams, 0 to 3 percent slopes	4,040	0.4
48	Glyndon silt loam	3,770	0.4
49	Glyndon silt loam, saline, 0 to 3 percent slopes	1,790	0.2
50	Hamerly-Tonka complex, 0 to 3 percent slopes	144,390	15.1
54	Lamoure silt loam, channeled	10,540	1.1
56	LaDelle silty clay loam	4,040	0.4
62	Overly-Bearden silty clay loams	7,110	0.7
63	Renshaw loam, 0 to 2 percent slopes	19,100	2.0
64	Pits, gravel	970	0.1
65	Svea-Barnes loams, 0 to 2 percent slopes	61,410	6.4
66	Hamerly-Wyard loams, 0 to 3 percent slopes	65,720	6.9
66B	Hamerly loam, 3 to 6 percent slopes	27,950	2.9
67C	Renshaw-Sioux loams, 2 to 9 percent slopes	12,470	1.3
68E	Sioux-Renshaw loams, 9 to 25 percent slopes	3,980	0.4
71	Vallers-Parnell complex	27,630	2.8
77	Vallers loam, saline	32,250	3.4
80	Marysland loam	3,200	0.3
81B	Edgeley loam, 2 to 6 percent slopes	520	0.1
82	Sinai silty clay loam, 0 to 2 percent slopes	910	0.1
82B	Sinai silty clay loam, 2 to 6 percent slopes	690	0.1
83F	Kloten-Buse complex, 9 to 35 percent slopes	12,480	1.3
84	Easby loam	3,360	0.4
85	Exline silty clay loam	1,430	0.1
86	Overly-Nahon silt loams	3,000	0.3
87	Svea-Cavour loams, 0 to 3 percent slopes	18,840	2.0
88	Manfred and Vallers soils, extremely stony	2,040	0.2
89	Fordville loam, 0 to 3 percent slopes	6,510	0.7
90	Dovray silty clay	650	0.1
91	Arveson loam	850	0.1
92B	Barnes-Cavour loams, 3 to 6 percent slopes	1,670	0.2
98B	Barnes-Svea loams, 0 to 6 percent slopes, extremely stony	2,050	0.2
	Water	13,790	1.4
	Total	956,800	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management, except the undrained yield is given for poorly drained and very poorly drained soils. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons
2. Tonka	16	34	26	8	800	2.8
3. Parnell	10	21	16	5	500	2.8
6. Southam						
9. Nutley	34	72	55	17	1,700	2.2
9B. Nutley	30	64	49	15	1,500	2.2
9D. Nutley	21	45	34	11	1,050	2.2
12. Lismore-Kranzburg	38	81	62	19	1,900	2.7
13B. Kranzburg-Lismore	32	68	52	16	1,600	2.6
14B. Barnes-Buse	28	60	46	14	1,400	2.0
14C. Barnes-Buse	22	47	36	11	1,100	2.0
14D. Barnes-Buse	15	32	24	8	750	2.0
15. Swenoda-Lanona	30	64	49	15	1,500	2.1
15B. Lanona-Swenoda	25	53	41	13	1,250	2.1
15C. Lanona	19	40	31	10	950	2.1
16B. Barnes-Sioux	24	51	39	12	1,200	1.9
16C. Barnes-Sioux	17	36	28	9	850	1.9
16E. Barnes-Sioux	---	---	---	---	---	1.8
17B. Barnes-Svea	34	72	55	17	1,700	2.6
18. Bearden	37	79	60	19	1,850	2.3
19. Colvin	12	26	25	6	600	2.1

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons
23F. Buse-Barnes						
26 Colvin	16	34	26	8	800	2.8
27 Divide	26	55	42	13	1,300	2.3
31B Egeland	24	51	39	12	1,200	2.1
36 Fargo	17	36	28	9	850	2.8
40B Gardena-Zell	30	64	49	15	1,500	2.0
40C Zell	16	34	26	8	800	1.3
40E. Zell						
43 Gardena	40	85	65	20	2,000	2.6
46 Gardena-Glyndon	38	81	62	19	1,900	2.5
48 Glyndon	38	81	62	19	1,900	2.3
49 Glyndon	24	51	45	12	1,200	2.1
50 Hamerly-Tonka	34	72	55	17	1,700	2.5
54 Lamoure	---	---	---	---	---	2.8
56 LaDelle	38	81	62	19	1,900	2.8
62 Overly-Bearden	39	83	63	20	1,950	2.4
63 Renshaw	19	40	31	10	950	1.8
64*. Pits						
65 Svea-Barnes	38	81	62	19	1,900	2.7
66 Hamerly-Wyard	35	74	57	18	1,750	2.3

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons
66B----------------------- Hamerly	30	64	49	15	1,500	2.3
67C----------------------- Renshaw-Sioux	12	26	20	6	600	1.4
68E. Sioux-Renshaw						
71----------------------- Vallers-Parnell	14	30	23	7	700	2.8
77----------------------- Vallers	9	19	20	5	450	2.1
80----------------------- Marysland	14	30	23	7	700	2.8
81B----------------------- Edgeley	27	57	44	14	1,350	1.8
82----------------------- Sinai	36	77	59	18	1,800	2.2
82B----------------------- Sinai	32	68	52	16	1,600	2.2
83F. Kloten-Buse						
84. Easby						
85----------------------- Exline	---	---	---	---	---	0.9
86----------------------- Overly-Nahon	32	68	52	16	1,600	2.2
87----------------------- Svea-Cavour	31	66	50	16	1,550	2.2
88----------------------- Manfred and Vallers	---	---	---	---	---	1.6
89----------------------- Fordville	25	53	41	13	1,250	2.6
90----------------------- Dovray	13	28	21	7	650	2.8
91----------------------- Arveson	12	26	20	6	600	2.8
92B----------------------- Barnes-Cavour	26	55	42	13	1,300	2.2
98B. Barnes-Svea						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
2 Tonka	Wet Meadow	5,000	4,500	4,000
3 Parnell	Wetland	7,000	6,600	6,000
6 Southam	None Assigned	-----	-----	-----
9 Nutley	Clayey	3,200	2,700	1,900
9B Nutley	Clayey	3,000	2,500	1,800
9D Nutley	Clayey	3,000	2,500	1,800
12*:				
Lismore	Overflow	4,000	3,600	3,100
Kranzburg	Silty	3,600	3,000	2,100
13B*:				
Kranzburg	Silty	3,600	3,000	2,100
Lismore	Silty	3,500	3,000	2,600
14B*, 14C*, 14D*:				
Barnes	Silty	3,200	2,700	2,300
Buse	Thin Upland	2,700	2,400	1,800
15*:				
Swenoda	Sandy	3,200	2,800	2,400
Lanona	Sandy	3,200	2,800	2,400
15B*:				
Lanona	Sandy	3,200	2,800	2,400
Swenoda	Sandy	3,200	2,800	2,400
15C Lanona	Sandy	3,200	2,800	2,400
16B*, 16C*, 16E*:				
Barnes	Silty	3,200	2,700	2,300
Sioux	Very Shallow	1,200	1,000	800
17B*:				
Barnes	Silty	3,200	2,700	2,300
Svea	Silty	3,500	3,000	2,600
18 Bearden	Limy Subirrigated	4,800	4,200	3,600

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season: Favorable Lb/acre	Average Lb/acre	Unfavorable Lb/acre
19: Colvin	Saline Lowland	3,500	3,200	2,800
23F*:				
Buse	Thin Upland	2,700	2,400	1,800
Barnes	Silty	3,200	2,700	2,300
26: Colvin	Wet Meadow	5,000	4,500	4,000
27: Divide	Limy Subirrigated	4,800	4,200	3,600
31B: Egeland	Sandy	3,500	2,900	2,000
36: Fargo	Clayey	3,200	2,800	2,400
40B*:				
Gardena	Silty	3,400	2,900	2,500
Zell	Thin Upland	3,200	2,700	1,900
40C: Zell	Thin Upland	3,200	2,700	1,900
40E: Zell	Thin Upland	3,000	2,500	1,700
43: Gardena	Silty	3,400	2,900	2,500
46*:				
Gardena	Silty	3,400	2,900	2,500
Glyndon	Limy Subirrigated	4,800	4,200	3,600
48: Glyndon	Limy Subirrigated	4,800	4,200	3,600
49: Glyndon	Saline Lowland	3,500	3,200	2,800
50*:				
Hamerly	Limy Subirrigated	4,800	4,200	3,600
Tonka	Wet Meadow	5,000	4,500	4,000
54: Lamoure	Subirrigated	6,400	5,800	4,600
56: LaDelle	Overflow	4,800	4,000	2,800
62*:				
Overly	Silty	3,400	2,900	2,500
Bearden	Limy Subirrigated	4,800	4,200	3,600

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable Lb/acre	Average Lb/acre	Unfavorable Lb/acre
63 Renshaw	Shallow to Gravel	2,500	2,100	1,300
64* Pits	None Assigned	-----	-----	-----
65*:				
Svea	Overflow	4,000	3,600	3,100
Barnes	Silty	3,200	2,700	2,300
66*:				
Hamerly	Limy Subirrigated	4,800	4,200	3,600
Wyard	Overflow	4,000	3,600	3,100
66B Hamerly	Limy Subirrigated	4,800	4,200	3,600
67C*:				
Renshaw	Shallow to Gravel	2,500	2,100	1,300
Sioux	Very Shallow	1,200	1,000	800
68E*:				
Sioux	Very Shallow	1,200	1,000	800
Renshaw	Shallow to Gravel	2,500	2,100	1,300
71*:				
Vallers	Subirrigated	5,800	5,300	4,200
Parnell	Wetland	7,000	6,600	6,000
77 Vallers	Saline Lowland	4,000	3,500	3,000
80 Marysland	Subirrigated	6,000	5,500	4,400
81B Edgeley	Silty	2,600	2,300	1,900
82, 82B Sinai	Clayey	3,200	2,700	1,900
83F*:				
Kloten	Shallow	2,300	2,000	1,700
Buse	Thin Upland	2,700	2,400	1,800
84 Easby	Saline Lowland	3,500	3,200	2,800
85 Exline	Thin Claypan	1,300	1,100	900
86*:				
Overly	Silty	3,400	2,900	2,500
Nahon	Claypan	2,500	2,100	1,500

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season: Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
87*:				
Svea	Overflow	4,000	3,600	3,100
Cavour	Claypan	2,300	2,000	1,600
88*:				
Manfred	Saline Lowland	3,500	3,200	2,800
Vallers	Subirrigated	4,800	4,400	3,900
89 Fordville	Silty	3,200	2,700	1,900
90 Dovray	Wetland	6,600	6,000	4,800
91 Arveson	Subirrigated	4,800	4,400	3,900
92B*:				
Barnes	Silty	3,200	2,700	2,300
Cavour	Claypan	2,300	2,000	1,600
98B*:				
Barnes	Silty	3,200	2,700	2,300
Svea	Silty	3,000	2,700	2,500

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
2----------------- Tonka	---	Eastern redcedar, common chokecherry, lilac, American plum, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
3----------------- Parnell	American plum-----	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
6. Southam					
9, 9B, 9D--------- Nutley	Peking cotoneaster	Russian olive, eastern redcedar, common chokecherry, lilac, silver buffaloberry, Siberian peashrub.	Green ash, Siberian elm, ponderosa pine, Manchurian crabapple.	---	---
12*:					
Lismore----------	---	Redosier dogwood, Peking cotoneaster, American plum, Siberian peashrub, common chokecherry, eastern redcedar, ponderosa pine.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
Kranzburg.					
13B*: Kranzburg.					
Lismore----------	---	Redosier dogwood, Peking cotoneaster, American plum, Siberian peashrub, common chokecherry, eastern redcedar, ponderosa pine.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
14B*, 14C*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
Buse	Siberian peashrub, lilac.	Ponderosa pine, Russian olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---
14D*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
Buse.					
15*:					
Swenoda	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
Lanona	---	Common chokecherry, Siberian peashrub, eastern redcedar, American plum, silver buffaloberry, Siberian crabapple, lilac.	Green ash, bur oak, ponderosa pine, Russian olive.	---	---
15B*:					
Lanona	---	Common chokecherry, Siberian peashrub, eastern redcedar, American plum, silver buffaloberry, Siberian crabapple, lilac.	Green ash, bur oak, ponderosa pine, Russian olive.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
15B*:					
Swenoda	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
15C Lanona	---	Common chokecherry, Siberian peashrub, eastern redcedar, American plum, silver buffaloberry, Siberian crabapple, lilac.	Green ash, bur oak, ponderosa pine, Russian olive.	---	---
16B*, 16C*, 16E*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
Sioux.					
17B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
18 Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Peking cotoneaster, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
19 Colvin	Silver buffaloberry, Siberian peashrub.	---	Russian olive, green ash, Siberian elm.	---	---
23F*: Buse.					
Barnes.					
26 Colvin	---	American plum, Siberian peashrub, common chokecherry, lilac, eastern redcedar, redosier dogwood.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood.
27 Divide	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
31B Egeland	Silver buffaloberry.	Manchurian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, lilac.	Green ash, bur oak, ponderosa pine, Russian olive, American plum.	---	---
36 Fargo	American plum	Eastern redcedar, lilac, common chokecherry, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
40B*: Gardena	---	American plum, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
40B*:					
Zell	Peking cotoneaster, Siberian peashrub, lilac, skunkbush sumac, silver buffaloberry.	Ponderosa pine, Russian olive, green ash, Rocky Mountain juniper, eastern redcedar.	Siberian elm	---	---
40C Zell	Peking cotoneaster, Siberian peashrub, lilac, skunkbush sumac, silver buffaloberry.	Ponderosa pine, Russian olive, green ash, Rocky Mountain juniper, eastern redcedar.	Siberian elm	---	---
40E. Zell					
43 Gardena	---	American plum, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
46*:					
Gardena	---	American plum, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
48----------------- Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
49----------------- Glyndon	Silver buffaloberry, Siberian peashrub.	---	Siberian elm, green ash, Russian olive.	---	---
50*:					
Hamerly----------	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
Tonka------------	---	Eastern redcedar, common chokecherry, lilac, American plum, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
54. Lamoure					
56. LaDelle					
62*:					
Overly-----------	---	Siberian peashrub, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
62*:					
Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Peking cotoneaster, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
63. Renshaw					
64*. Pits					
65*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
66*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Wyard	---	Siberian peashrub, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
66B Hamerly	---	Redosier dogwood, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
67C*: Renshaw.					
Sioux.					
68E*: Sioux.					
Renshaw.					
71*: Vallers	American plum	Eastern redcedar, common chokecherry, lilac, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
Parnell	American plum	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
77 Vallers	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian olive.	---	---
80 Marysland	American plum	Eastern redcedar, common chokecherry, lilac, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
81B Edgeley	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Bur oak, Siberian crabapple, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
82, 82B Sinai	Peking cotoneaster	Russian olive, eastern redcedar, common chokecherry, lilac, silver buffaloberry, Siberian peashrub.	Green ash, Siberian elm, ponderosa pine, Manchurian crabapple.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
83F*: Kloten.					
Buse.					
84. Easby					
85. Exline					
86*: Overly	---	Siberian peashrub, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Nahon.					
87*: Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Cavour	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian olive, eastern redcedar.	---	---	---
88*: Manfred.					
Vallers.					
89 Fordville	Siberian peashrub, lilac, silver buffaloberry.	Rocky Mountain juniper, green ash, Siberian crabapple, common chokecherry, Russian olive, eastern redcedar.	Ponderosa pine	---	---
90 Dovray	American plum	Eastern redcedar, common chokecherry, lilac, Amur honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
91----------------- Arveson	American plum-----	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
92B*:					
Barnes-----------	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
Cavour-----------	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian olive, eastern redcedar.	---	---	---
98B*:					
Barnes.					
Svea.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
2 Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
3 Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
6 Southam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
9 Nutley	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.
9B Nutley	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
9D Nutley	Moderate: slope, too clayey.	Moderate: slope, too clayey.	Severe: slope.	Moderate: too clayey.
12*:				
Lismore	Slight	Slight	Slight	Slight.
Kranzburg	Slight	Slight	Slight	Slight.
13B*:				
Kranzburg	Slight	Slight	Moderate: slope.	Slight.
Lismore	Slight	Slight	Moderate: slope.	Slight.
14B*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
14C*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
14D*:				
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
15*:				
Swenoda	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
15*:				
Lanona	Slight	Slight	Slight	Slight.
15B*:				
Lanona	Slight	Slight	Moderate: slope.	Slight.
Swenoda	Slight	Slight	Moderate: slope.	Slight.
15C Lanona	Slight	Slight	Severe: slope.	Slight.
16B*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Sioux	Slight	Slight	Moderate: slope, small stones.	Slight.
16C*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Sioux	Slight	Slight	Severe: slope.	Slight.
16E*:				
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Sioux	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
17B*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.
Svea	Slight	Slight	Moderate: slope, small stones.	Slight.
18 Bearden	Moderate: wetness.	Moderate: wetness, percs slowly.	Moderate: wetness.	Slight.
19 Colvin	Severe: flooding, wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
23F*:				
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
26 Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
27 Divide	Slight	Slight	Slight	Slight.
31B Egeland	Slight	Slight	Moderate: slope.	Slight.
36 Fargo	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
40B*:				
Gardena	Slight	Slight	Moderate: slope.	Slight.
Zell	Slight	Slight	Moderate: slope.	Slight.
40C Zell	Slight	Slight	Severe: slope.	Slight.
40E Zell	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
43 Gardena	Slight	Slight	Slight	Slight.
46*:				
Gardena	Slight	Slight	Slight	Slight.
Glyndon	Slight	Slight	Slight	Slight.
48 Glyndon	Slight	Slight	Slight	Slight.
49 Glyndon	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
50*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
54 Lamoure	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.
56 LaDelle	Severe: flooding.	Slight	Moderate: flooding.	Slight.
62*:				
Overly	Slight	Slight	Slight	Slight.
Bearden	Moderate: wetness.	Moderate: wetness, percs slowly.	Moderate: wetness.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
63 Renshaw	Slight	Slight	Slight	Slight.
64*. Pits				
65*: Svea	Slight	Slight	Moderate: small stones.	Slight.
Barnes	Slight	Slight	Moderate: small stones.	Slight.
66*: Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Wyard	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
66B Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight.
67C*: Renshaw	Slight	Slight	Moderate: slope.	Slight.
Sioux	Slight	Slight	Moderate: slope, small stones.	Slight.
68E*: Sioux	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Renshaw	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
71*: Vallers	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
77 Vallers	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
80 Marysland	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
81B Edgeley	Slight	Slight	Moderate: slope, thin layer, area reclaim.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
82 Sinai	Slight	Slight	Slight	Slight.
82B Sinai	Slight	Slight	Moderate: slope.	Slight.
83F*:				
Kloten	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Moderate: slope.
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
84 Easby	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
85 Exline	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
86*:				
Overly	Slight	Slight	Slight	Slight.
Nahon	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
87*:				
Svea	Slight	Slight	Moderate: small stones.	Slight.
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
88*:				
Manfred	Severe: large stones, ponding, excess sodium.	Severe: ponding, large stones, excess sodium.	Severe: large stones, ponding, excess sodium.	Severe: ponding.
Vallers	Severe: large stones, wetness.	Severe: large stones.	Severe: large stones, wetness.	Moderate: wetness.
89 Fordville	Slight	Slight	Slight	Slight.
90 Dovray	Severe: ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding.	Severe: ponding, too clayey.
91 Arveson	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
92B*:				
Barnes	Slight	Slight	Moderate: slope, small stones.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
92B*:				
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
98B*:				
Barnes	Slight	Slight	Severe: large stones.	Slight.
Svea	Severe: large stones.	Severe: large stones.	Severe: large stones.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
2: Tonka	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
3: Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
6: Southam	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
9: Nutley	Good	Fair	Fair	Poor	Poor	Very poor	Fair	Very poor	Fair.
9B: Nutley	Fair	Fair	Poor	Poor	Poor	Very poor	Fair	Very poor	Poor.
9D: Nutley	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
12*:									
Lismore	Good	Good	Good	---	Very poor	Very poor	Good	Very poor	Good.
Kranzburg	Good	Good	Good	---	Poor	Very poor	Good	Very poor	Good.
13B*:									
Kranzburg	Good	Good	Good	---	Poor	Very poor	Good	Very poor	Good.
Lismore	Good	Good	Good	---	Very poor	Very poor	Good	Very poor	Good.
14B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
14C*:									
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
14D*:									
Barnes	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
15*:									
Swenoda	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Lanona	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
15B*:									
Lanona	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Swenoda	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
15C: Lanona	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
16B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
16C*:									
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
16E*:									
Barnes	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
17B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
18 Bearden	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
19 Colvin	Poor	Fair	Poor	Fair	Good	Good	Poor	Good	Poor.
23F*:									
Buse	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Barnes	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
26 Colvin	Poor	Fair	Fair	Fair	Good	Good	Poor	Good	Fair.
27 Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
31B Egeland	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
36 Fargo	Good	Good	Fair	Poor	Poor	Good	Fair	Fair	Poor.
40B*:									
Gardena	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Zell	Poor	Fair	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
40C Zell	Poor	Fair	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
40E Zell	Very poor	Fair	Fair	Fair	Very poor	Very poor	Very poor	Very poor	Fair.
43 Gardena	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
46*:									
Gardena	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
46*:									
Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
48 Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
49 Glyndon	Fair	Fair	Good	Fair	Poor	Poor	Fair	Poor	Fair.
50*:									
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Tonka	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
54 Lamoure	Very poor	Poor	Fair	Fair	Fair	Fair	Poor	Fair	Fair.
56 LaDelle	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
62*:									
Overly	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Bearden	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
63 Renshaw	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
64*. Pits									
65*:									
Svea	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
66*:									
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Wyard	Good	Good	Good	Good	Fair	Fair	Good	Fair	Good.
66B Hamerly	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
67C*:									
Renshaw	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
68E*:									
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Renshaw	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
71*:									
Vallers	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
77 Vallers	Poor	Fair	Very poor	Very poor	Good	Good	Poor	Good	Very poor.
80 Marysland	Good	Good	Fair	Fair	Good	Good	Fair	Good	Fair.
81B Edgeley	Good	Good	Good	Fair	Poor	Poor	Good	Very poor	Fair.
82 Sinai	Good	Fair	Good	---	Very poor	Very poor	Good	Poor	Good.
82B Sinai	Fair	Fair	Good	---	Very poor	Very poor	Fair	Very poor	Good.
83F*:									
Kloten	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Buse	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
84 Easby	Poor	Poor	Very poor	Very poor	Good	Good	Poor	Good	Very poor.
85 Exline	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Poor	Fair.
86*:									
Overly	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Nahon	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Poor	Poor.
87*:									
Svea	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Cavour	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Poor.
88*:									
Manfred	Very poor	Very poor	Very poor	Very poor	Good	Fair	Very poor	Very poor	Very poor.
Vallers	Poor	Poor	Very poor	Fair	Good	Fair	Poor	Fair	Poor.
89 Fordville	Fair	Good	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
90 Dovray	Poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
91 Arveson	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
92B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Cavour	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Poor.
98B*:									
Barnes	Very poor	Very poor	Good	Fair	Very poor	Very poor	Very poor	Very poor	Fair.
Svea	Poor	Poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
2----------------- Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
3----------------- Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
6----------------- Southam	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
9, 9B------------- Nutley	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
9D---------------- Nutley	Moderate: too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength.
12*:					
Lismore----------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
Kranzburg--------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
13B*:					
Kranzburg--------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.
Lismore----------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: slope, shrink-swell.	Severe: low strength, frost action.
14B*, 14C*:					
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
Buse-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
14D*:					
Barnes-----------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, shrink-swell.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
14D*:					
Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, shrink-swell.
15*:					
Swenoda	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.
Lanona	Slight	Slight	Moderate: shrink-swell.	Slight	Moderate: frost action.
15B*:					
Lanona	Slight	Slight	Moderate: shrink-swell.	Moderate: slope.	Moderate: frost action.
Swenoda	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Moderate: slope.	Moderate: frost action.
15C Lanona	Slight	Slight	Moderate: shrink-swell.	Moderate: slope.	Moderate: frost action.
16B*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.
Sioux	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
16C*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
Sioux	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
16E*:					
Barnes	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, shrink-swell.
Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
17B*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
18----------------- Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
19----------------- Colvin	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
23F*:					
Buse--------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
26----------------- Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.
27----------------- Divide	Severe: cutbanks cave.	Slight-----------	Moderate: wetness.	Slight------------	Moderate: frost action.
31B---------------- Egeland	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Slight.
36----------------- Fargo	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.
40B*:					
Gardena-----------	Moderate: wetness.	Slight-----------	Moderate: wetness.	Moderate: slope.	Severe: frost action.
Zell--------------	Slight-----------	Slight-----------	Slight-----------	Moderate: slope.	Severe: frost action.
40C---------------- Zell	Slight-----------	Slight-----------	Slight-----------	Moderate: slope.	Severe: frost action.
40E---------------- Zell	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action.
43----------------- Gardena	Moderate: wetness.	Slight-----------	Moderate: wetness.	Slight------------	Severe: frost action.
46*:					
Gardena-----------	Moderate: wetness.	Slight-----------	Moderate: wetness.	Slight------------	Severe: frost action.
Glyndon-----------	Severe: cutbanks cave.	Slight-----------	Moderate: wetness.	Slight------------	Severe: frost action.
48, 49------------- Glyndon	Severe: cutbanks cave.	Slight-----------	Moderate: wetness.	Slight------------	Severe: frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
50*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
54 Lamoure	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
56 LaDelle	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
62*:					
Overly	Moderate: too clayey, wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.
Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
63 Renshaw	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
64*. Pits					
65*:					
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.
66*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
66B Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: frost action.
67C*:					
Renshaw	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
67C*:					
Sioux	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
68E*:					
Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Renshaw	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
71*:					
Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
77 Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
80 Marysland	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: frost action.
81B Edgeley	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
82, 82B Sinai	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
83F*:					
Kloten	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
84 Easby	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.
85 Exline	Severe: cutbanks cave.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
86*:					
Overly	Moderate: too clayey, wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
86*:					
Nahon	Severe: cutbanks cave.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
87*:					
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Cavour	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
88*:					
Manfred	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.
89 Fordville	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
90 Dovray	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
91 Arveson	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
92B*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
Cavour	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
98B*:					
Barnes	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
2------------------ Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
3------------------ Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
6------------------ Southam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
9------------------ Nutley	Severe: percs slowly.	Slight-----------	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
9B----------------- Nutley	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
9D----------------- Nutley	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
12*:					
Lismore------------	Severe: percs slowly.	Slight-----------	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Kranzburg----------	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
13B*:					
Kranzburg----------	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Lismore------------	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
14B*:					
Barnes-------------	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Buse---------------	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
14C*:					
Barnes-------------	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
14C*:					
Buse	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
14D*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
15*:					
Swenoda	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
Lanona	Severe: percs slowly.	Severe: seepage.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.
15B*:					
Lanona	Severe: percs slowly.	Severe: seepage.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.
Swenoda	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
15C Lanona	Severe: percs slowly.	Severe: seepage, slope.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.
16B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
16C*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Sioux	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
16E*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
17B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
18 Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
19 Colvin	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
23F*:					
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Barnes	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
26 Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
27 Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
31B Egeland	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
36 Fargo	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
40B*:					
Gardena	Moderate: wetness.	Moderate: seepage, slope, wetness.	Severe: wetness.	Moderate: wetness.	Good.
Zell	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
40C Zell	Moderate: percs slowly.	Severe: slope.	Slight	Slight	Good.
40E Zell	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
43: Gardena	Moderate: wetness.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.
46*:					
Gardena	Moderate: wetness.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.
Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
48: Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
49: Glyndon	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
50*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
54: Lamoure	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
56: LaDelle	Severe: flooding.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Poor: hard to pack.
62*:					
Overly	Severe: percs slowly.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Poor: thin layer.
Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
63: Renshaw	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
64*. Pits					

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
65*:					
Svea	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Barnes	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
66*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
66B Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
67C*:					
Renshaw	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
68E*:					
Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Renshaw	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
71*:					
Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
77 Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
80 Marysland	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
81B Edgeley	Severe: thin layer, seepage.	Severe: seepage.	Severe: seepage.	Moderate: seepage.	Poor: area reclaim, hard to pack.
82 Sinai	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
82B Sinai	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
83F*:					
Kloten	Severe: seepage, thin layer, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: thin layer, slope, area reclaim.
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
84 Easby	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess salt.	Severe: wetness.	Poor: hard to pack, wetness, excess salt.
85 Exline	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey, too sandy.	Severe: wetness.	Poor: too clayey, hard to pack, excess sodium.
86*:					
Overly	Severe: percs slowly.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Poor: thin layer.
Nahon	Severe: percs slowly.	Slight	Severe: wetness, too clayey, excess sodium.	Moderate: wetness.	Poor: too clayey, hard to pack, excess sodium.
87*:					
Svea	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Cavour	Severe: percs slowly.	Slight	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
88*:					
Manfred	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, excess sodium.	Severe: ponding.	Poor: hard to pack, ponding, excess sodium.
Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
89------------------ Fordville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: small stones, too sandy, seepage.
90------------------ Dovray	Severe: ponding, percs slowly.	Slight-----------	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
91------------------ Arveson	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness, thin layer.
92B*:					
Barnes-------------	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Cavour-------------	Severe: percs slowly.	Moderate: slope.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
98B*:					
Barnes-------------	Severe: percs slowly.	Moderate: seepage, slope, large stones.	Moderate: too clayey.	Slight-----------	Fair: too clayey, large stones.
Svea---------------	Severe: percs slowly.	Moderate: seepage, slope, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
2 Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
3 Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
6 Southam	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
9, 9B, 9D Nutley	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
12*:				
Lismore	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Kranzburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
13B*:				
Kranzburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Lismore	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
14B*, 14C*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
14D*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
15*:				
Swenoda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
15*:				
Lanona	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
15B*:				
Lanona	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Swenoda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
15C Lanona	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
16B*, 16C*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
16E*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Sioux	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
17B*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
18 Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
19 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
23F*:				
Buse	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Barnes	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
26 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
27 Divide	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
31B Egeland	Good	Probable	Improbable: too sandy.	Good.
36 Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, too clayey.
40B*:				
Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Zell	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
40C Zell	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
40E Zell	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
43 Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
46*:				
Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
48 Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
49 Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
50*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
54 Lamoure	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
56 LaDelle	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
62*:				
Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
63 Renshaw	Good	Probable	Probable	Poor: small stones, area reclaim.
64*. Pits				
65*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
66*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Wyard	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
66B Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
67C*:				
Renshaw	Good	Probable	Probable	Poor: small stones, area reclaim.
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
68E*:				
Sioux	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
Renshaw	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
71*:				
Vallers	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Parnell	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
77 Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
80 Marysland	Fair: wetness.	Probable	Probable	Fair: area reclaim, small stones, thin layer.
81B Edgeley	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
82, 82B Sinai	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
83F*:				
Kloten	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
Buse	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
84 Easby	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
85 Exline	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
86*:				
Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Nahon	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium, excess salt.
87*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
87*:				
Cavour	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
88*:				
Manfred	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness, excess sodium.
Vallers	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
89 Fordville	Good	Probable	Probable	Fair: thin layer.
90 Dovray	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
91 Arveson	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
92B*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Cavour	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
98B*:				
Barnes	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
2 Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
3 Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
6 Southam	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
9 Nutley	Slight	Severe: hard to pack.	Deep to water	Droughty, slow intake.	Percs slowly	Droughty, percs slowly.
9B Nutley	Moderate: slope.	Severe: hard to pack.	Deep to water	Slope, droughty, slow intake.	Percs slowly	Droughty, percs slowly.
9D Nutley	Severe: slope.	Severe: hard to pack.	Deep to water	Slope, droughty, slow intake.	Slope, percs slowly.	Slope, droughty, percs slowly.
12*:						
Lismore	Slight	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
Kranzburg	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable	Favorable	Favorable.
13B*:						
Kranzburg	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Favorable	Favorable.
Lismore	Moderate: slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
14B*, 14C*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
14D*:						
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
15*:						
Swenoda	Severe: seepage.	Severe: piping.	Favorable	Wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
15*:						
Lanona	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
15B*:						
Lanona	Severe: seepage.	Severe: piping.	Deep to water	Slope, soil blowing.	Soil blowing	Favorable.
Swenoda	Severe: seepage.	Severe: piping.	Slope	Slope, wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.
15C Lanona	Severe: seepage.	Severe: piping.	Deep to water	Slope, soil blowing.	Soil blowing	Favorable.
16B*:						
Barnes	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
16C*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
16E*:						
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Droughty, slope.
17B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
18 Bearden	Moderate: seepage.	Moderate: piping, hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
19 Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly, flooding.	Wetness, percs slowly.	Wetness, excess salt, percs slowly.
23F*:						
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
26 Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
27 Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
31B Egeland	Severe: seepage.	Severe: piping, seepage.	Deep to water	Soil blowing, slope, droughty.	Soil blowing, too sandy.	Droughty.
36 Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
40B*:						
Gardena	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Zell	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
40C Zell	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
40E Zell	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
43 Gardena	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
46*:						
Gardena	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness	Favorable.
48 Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness	Favorable.
49 Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave, excess salt.	Wetness, excess salt.	Wetness	Excess salt.
50*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
54 Lamoure	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
56 LaDelle	Moderate: seepage.	Severe: hard to pack.	Deep to water	Flooding	Favorable	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
62*:						
Overly	Slight	Severe: piping.	Deep to water	Percs slowly	Favorable	Percs slowly.
Bearden	Moderate: seepage.	Moderate: piping, hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
63 Renshaw	Severe: seepage.	Severe: seepage.	Deep to water	Droughty	Too sandy	Droughty.
64*. Pits						
65*:						
Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Barnes	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
66*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Wyard	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Wetness, erodes easily.
66B Hamerly	Moderate: slope.	Severe: piping.	Frost action, slope.	Slope, wetness.	Erodes easily, wetness.	Erodes easily.
67C*:						
Renshaw	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
68E*:						
Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Droughty, slope.
Renshaw	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Slope, droughty.
71*:						
Vallers	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
77 Vallers	Slight	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
80----------------- Marysland	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness---------	Wetness, too sandy.	Wetness.
81B---------------- Edgeley	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope, thin layer.	Area reclaim---	Area reclaim.
82----------------- Sinai	Slight---------	Moderate: hard to pack.	Deep to water	Percs slowly---	Erodes easily, percs slowly.	Erodes easily, percs slowly.
82B---------------- Sinai	Moderate: slope.	Moderate: hard to pack.	Deep to water	Percs slowly, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
83F*:						
Kloten------------	Severe: seepage, slope.	Severe: piping, thin layer.	Deep to water	Slope, thin layer.	Slope, area reclaim.	Slope, area reclaim.
Buse--------------	Severe: slope.	Severe: piping.	Deep to water	Slope-----------	Slope, erodes easily.	Slope, erodes easily.
84----------------- Easby	Slight---------	Severe: piping, hard to pack, wetness.	Frost action, excess salt.	Wetness, droughty, excess salt.	Wetness---------	Wetness, excess salt, droughty.
85----------------- Exline	Slight---------	Severe: excess sodium.	Percs slowly, cutbanks cave, excess salt.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Excess sodium, erodes easily, percs slowly.
86*:						
Overly------------	Slight---------	Severe: piping.	Deep to water	Percs slowly---	Favorable------	Percs slowly.
Nahon-------------	Slight---------	Severe: hard to pack, excess sodium.	Deep to water	Percs slowly, excess sodium, excess salt.	Percs slowly, erodes easily.	Excess sodium, percs slowly, erodes easily.
87*:						
Svea--------------	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Cavour------------	Slight---------	Severe: excess sodium.	Deep to water	Percs slowly, rooting depth.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
88*:						
Manfred-----------	Slight---------	Severe: ponding, excess sodium.	Ponding, percs slowly, frost action.	Ponding, percs slowly, excess sodium.	Large stones, ponding, percs slowly.	Large stones, wetness, excess sodium.
Vallers-----------	Moderate: seepage.	Severe: piping, wetness.	Frost action---	Wetness---------	Wetness---------	Wetness.
89----------------- Fordville	Severe: seepage.	Severe: seepage.	Deep to water	Favorable------	Too sandy------	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
90----------------- Dovray	Slight----------	Severe: hard to pack, ponding.	Ponding, percs slowly.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
91----------------- Arveson	Severe: seepage.	Severe: piping, wetness.	Frost action---	Wetness---------	Wetness---------	Wetness.
92B*:						
Barnes-----------	Moderate: slope.	Severe: piping.	Deep to water	Slope-----------	Erodes easily	Erodes easily.
Cavour-----------	Moderate: slope.	Severe: excess sodium.	Deep to water	Slope, percs slowly, rooting depth.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
98B*:						
Barnes-----------	Moderate: slope.	Severe: piping.	Deep to water	Slope, large stones.	Large stones---	Large stones.
Svea-------------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope-----------	Erodes easily	Erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
2---------------- Tonka	0-18	Silt loam--------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	18-39	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	39-60	Silty clay loam, clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	60-100	50-90	25-50	5-30
3---------------- Parnell	0-8	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
	8-35	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	35-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
6---------------- Southam	0-24	Silty clay loam	CL	A-6, A-7	0	100	95-100	90-100	85-100	30-50	10-25
	24-49	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	95-100	90-100	85-100	40-75	15-50
	49-60	Silty clay, silty clay loam, loam.	CL, CH, CL-ML	A-6, A-7, A-4	0	100	95-100	85-100	60-100	20-75	5-50
9, 9B, 9D-------- Nutley	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
	8-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	90-100	85-100	50-80	25-50
12*:											
Lismore---------	0-11	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-25
	11-20	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	95-100	85-100	30-50	10-25
	20-40	Loam, clay loam	CL	A-6, A-7	0	100	95-100	85-100	70-85	30-50	10-25
	40-60	Loam, clay loam	CL	A-6, A-7	0	95-100	90-100	80-100	60-85	30-50	10-25
Kranzburg-------	0-8	Silty clay loam	CL, CH	A-7	0	100	100	95-100	90-100	40-55	15-30
	8-19	Silty clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
	19-34	Clay loam, loam	CL	A-6, A-7	0	95-100	90-100	80-100	65-85	30-50	10-30
	34-60	Clay loam, loam	CL	A-6, A-7	0	95-100	90-100	80-100	65-85	30-50	10-30
13B*:											
Kranzburg-------	0-8	Silty clay loam	CL, CH	A-7	0	100	100	95-100	90-100	40-55	15-30
	8-19	Silty clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
	19-34	Clay loam, loam	CL	A-6, A-7	0	95-100	90-100	80-100	65-85	30-50	10-30
	34-60	Clay loam, loam	CL	A-6, A-7	0	95-100	90-100	80-100	65-85	30-50	10-30
Lismore---------	0-11	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-25
	11-20	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	95-100	85-100	30-50	10-25
	20-40	Loam, clay loam	CL	A-6, A-7	0	100	95-100	85-100	70-85	30-50	10-25
	40-60	Loam, clay loam	CL	A-6, A-7	0	95-100	90-100	80-100	60-85	30-50	10-25
14B*, 14C*, 14D*:											
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
14B*, 14C*, 14D*:											
Buse	0-6	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	6-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
15*:											
Swenoda	0-8	Fine sandy loam	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
	8-34	Fine sandy loam, sandy loam.	SP-SM, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-100	30-55	15-30	NP-10
	34-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	90-100	75-100	50-95	25-50	5-30
Lanona	0-8	Fine sandy loam	SM, SC, SM-SC	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-10
	8-28	Fine sandy loam, sandy loam.	SM, SM-SC, SC	A-2, A-4	0	100	95-100	60-100	30-50	20-30	NP-10
	28-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-100	50-95	25-45	5-20
15B*:											
Lanona	0-8	Fine sandy loam	SM, SC, SM-SC	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-10
	8-28	Fine sandy loam, sandy loam.	SM, SM-SC, SC	A-2, A-4	0	100	95-100	60-100	30-50	20-30	NP-10
	28-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-100	50-95	25-45	5-20
Swenoda	0-8	Fine sandy loam	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
	8-34	Fine sandy loam, sandy loam.	SP-SM, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-100	30-55	15-30	NP-10
	34-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	90-100	75-100	50-95	25-50	5-30
15C Lanona	0-8	Fine sandy loam	SM, SC, SM-SC	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-10
	8-28	Fine sandy loam, sandy loam.	SM, SM-SC, SC	A-2, A-4	0	100	95-100	60-100	30-50	20-30	NP-10
	28-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-100	50-95	25-45	5-20
16B*, 16C*, 16E*:											
Barnes	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Sioux	0-6	Loam	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	6-8	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	8-60	Extremely gravelly coarse sand, very gravelly loamy sand, very gravelly coarse sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
17B*:											
Barnes	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
17B*:											
Svea	0-12	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	12-25	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	25-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30
18 Bearden	0-9	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
	9-32	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-55	10-30
	32-46	Silt loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-55	10-30
	46-60	Silt loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-60	10-30
19 Colvin	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	30-50	15-30
	8-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	20-50	10-30
23F*:											
Buse	0-6	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	6-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
Barnes	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
26 Colvin	0-11	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	35-50	15-30
	11-31	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	31-60	Sandy loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
27 Divide	0-11	Loam	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
	11-28	Loam, clay loam, gravelly loam.	CL, CL-ML, SM-SC, SC	A-4, A-6, A-7	0-3	95-100	75-100	55-90	35-80	20-45	5-20
	28-60	Sand, gravelly sand, gravelly coarse sand.	GM, SM, GP-GM, SP-SM	A-1	0-5	25-85	15-65	10-40	5-25	<30	NP-5
31B Egeland	0-9	Fine sandy loam	SM, SM-SC	A-2, A-4	0	100	95-100	75-100	30-50	<30	NP-7
	9-40	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	0	95-100	85-100	70-100	15-50	<30	NP-7
	40-60	Fine sandy loam, sandy loam, loamy very fine sand.	SM, SP-SM, SM-SC	A-2, A-4	0	95-100	85-100	70-100	10-45	<25	NP-5
36 Fargo	0-8	Silty clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	8-19	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	19-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
40B*:											
Gardena	0-24	Silt loam	ML, CL-ML, CL	A-4, A-6	0	100	100	75-100	60-100	25-40	NP-15
	24-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4, A-6	0	100	100	75-100	55-100	20-40	NP-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
40B*:											
Zell------------	0-8	Silt loam--------	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
	8-23	Silt loam, very fine sandy loam, loam.	CL, ML, CL-ML	A-4, A-6	0	100	95-100	85-100	70-100	25-40	5-15
	23-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML	A-4	0	100	95-100	85-100	60-100	<30	NP-7
40C, 40E--------- Zell	0-8	Silt loam--------	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
	8-23	Silt loam, very fine sandy loam, loam.	CL, ML, CL-ML	A-4, A-6	0	100	95-100	85-100	70-100	25-40	5-15
	23-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML	A-4	0	100	95-100	85-100	60-100	<30	NP-7
43--------------- Gardena	0-24	Silt loam--------	ML, CL-ML, CL	A-4, A-6	0	100	100	75-100	60-100	25-40	NP-15
	24-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4, A-6	0	100	100	75-100	55-100	20-40	NP-15
46*:											
Gardena---------	0-24	Silt loam--------	ML, CL-ML, CL	A-4, A-6	0	100	100	75-100	60-100	25-40	NP-15
	24-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4, A-6	0	100	100	75-100	55-100	20-40	NP-15
Glyndon---------	0-11	Silt loam--------	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	11-50	Silt loam, very fine sandy loam, silty clay loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	80-100	20-40	NP-10
	50-60	Loamy very fine sand, fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0	100	100	85-100	35-75	10-35	NP-15
48--------------- Glyndon	0-11	Silt loam--------	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	11-50	Silt loam, very fine sandy loam, silty clay loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	80-100	20-40	NP-10
	50-60	Loamy very fine sand, fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0	100	100	85-100	35-75	10-35	NP-15
49--------------- Glyndon	0-9	Silt loam--------	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	9-60	Silt loam, very fine sandy loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	80-95	20-30	NP-10
50*:											
Hamerly---------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	7-37	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	37-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
50*:											
Tonka	0-18	Silt loam	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	18-39	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	39-60	Silty clay loam, clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	60-100	50-90	25-50	5-30
54 Lamoure	0-16	Silt loam	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	16-40	Silty clay loam, silt loam.	CL, CH, MH, ML	A-7	0	100	100	90-100	85-100	40-70	15-35
	40-60	Stratified loamy coarse sand to silty clay loam.	CL, SC	A-6, A-7	0	95-100	95-100	70-95	35-90	30-50	10-25
56 LaDelle	0-11	Silty clay loam	CL, ML, MH	A-6, A-7	0	100	100	95-100	85-100	35-55	10-25
	11-30	Silt loam, silty clay loam, loam.	CL, ML, MH, CH	A-6, A-7	0	100	100	90-100	75-100	30-55	10-25
	30-60	Stratified silt loam to silty clay loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	100	90-100	75-100	25-50	5-25
62*:											
Overly	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-100	30-45	10-25
	8-37	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	37-60	Stratified very fine sandy loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
Bearden	0-9	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
	9-32	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-55	10-30
	32-46	Silt loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-55	10-30
	46-60	Silt loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	90-100	80-95	25-60	10-30
63 Renshaw	0-8	Loam	ML, CL	A-4, A-6	0-5	95-100	90-100	70-100	50-75	30-40	5-15
	8-16	Loam, sandy clay loam, gravelly loam.	SM-SC, SC, ML, CL	A-4, A-6	0-5	95-100	55-100	45-90	35-70	25-40	3-15
	16-60	Loamy coarse sand, very gravelly sand, gravelly coarse sand.	SW, SM, SW-SM, GW-GM	A-1	0-5	45-95	30-80	10-50	0-15	<25	NP-5
64*. Pits											
65*:											
Svea	0-12	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	12-25	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	25-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
65*:											
Barnes	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
66*:											
Hamerly	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	7-37	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	37-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
Wyard	0-30	Loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	85-100	60-90	25-40	5-20
	30-60	Loam, sandy loam, clay loam.	SM, ML, CL, SC	A-4, A-6, A-7	0-10	95-100	95-100	80-100	35-85	20-45	3-25
66B Hamerly	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	7-37	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	37-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
67C*:											
Renshaw	0-8	Loam	ML, CL	A-4, A-6	0-5	95-100	90-100	70-100	50-75	30-40	5-15
	8-16	Loam, sandy clay loam, gravelly loam.	SM-SC, SC, ML, CL	A-4, A-6	0-5	95-100	55-100	45-90	35-70	25-40	3-15
	16-60	Loamy coarse sand, very gravelly sand, gravelly coarse sand.	SW, SM, SW-SM, GW-GM	A-1	0-5	45-95	30-80	10-50	0-15	<25	NP-5
Sioux	0-6	Loam	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	6-8	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	8-60	Extremely gravelly coarse sand, very gravelly loamy sand, very gravelly coarse sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
68E*:											
Sioux	0-6	Loam	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	6-8	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	8-60	Extremely gravelly coarse sand, very gravelly loamy sand, very gravelly coarse sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
68E*:											
Renshaw----------	0-8	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	90-100	70-100	50-75	30-40	5-15
	8-16	Loam, sandy clay loam, gravelly loam.	SM-SC, SC, ML, CL	A-4, A-6	0-5	95-100	55-100	45-90	35-70	25-40	3-15
	16-60	Loamy coarse sand, very gravelly sand, gravelly coarse sand.	SW, SM, SW-SM, GW-GM	A-1	0-5	45-95	30-80	10-50	0-15	<25	NP-5
71*:											
Vallers----------	0-7	Loam-------------	OL, ML	A-4	0	95-100	90-100	80-90	50-80	30-40	4-10
	7-32	Clay loam, silty clay loam, loam.	CL	A-6	0	95-100	90-100	80-95	50-80	30-40	11-20
	32-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-85	20-40	5-20
Parnell----------	0-8	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
	8-35	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	35-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
77--------------- Vallers	0-11	Loam-------------	ML	A-4	0	95-100	90-100	80-90	65-80	25-40	3-10
	11-35	Clay loam, loam	CL	A-6	0	95-100	90-100	90-95	70-80	30-40	10-20
	35-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-75	20-40	5-20
80--------------- Marysland	0-8	Loam-------------	CL	A-6, A-7	0	95-100	95-100	85-95	50-80	30-50	10-25
	8-34	Loam, clay loam, sandy clay loam.	CL, SC	A-6	0	90-100	85-100	80-95	45-80	20-40	10-20
	34-60	Stratified gravelly fine sand to gravelly coarse sand.	SP-SM, SM	A-1, A-2, A-3	0	70-95	50-90	35-70	5-20	---	NP
81B-------------- Edgeley	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	85-95	60-75	20-40	5-25
	8-32	Clay loam, channery silty clay loam, loam.	CL, CH, MH	A-6, A-7	0-5	80-100	75-100	65-95	55-95	25-65	10-40
	32-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
82, 82B---------- Sinai	0-9	Silty clay loam	CL, CH, MH, ML	A-7	0	100	100	95-100	90-100	45-60	15-30
	9-18	Silty clay, silty clay loam, clay.	CL, CH, MH, ML	A-7	0	100	100	95-100	90-100	45-70	20-35
	18-49	Silty clay, silty clay loam, clay.	CL, CH, MH, ML	A-7	0	100	100	95-100	90-100	45-70	20-35
	49-60	Stratified silty clay to silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-65	15-40
83F*:											
Kloten-----------	0-5	Silty clay loam	CL	A-6	0-10	90-100	90-100	85-95	60-90	30-40	10-20
	5-16	Very channery silty clay loam, channery loam, silty clay loam.	CL-ML, CL	A-4, A-6	0-10	90-100	80-100	70-95	60-90	20-40	5-20
	16-60	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
83F*:											
Buse-----------	0-6	Loam------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	6-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
84-------------- Easby	0-16	Loam------------	CL-ML, CL, ML, MH	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-90	25-55	5-25
	16-60	Clay loam, loam, silty clay loam.	CL, CL-ML, CH, MH	A-4, A-6, A-7	0-5	95-100	90-100	80-95	55-75	25-55	5-25
85-------------- Exline	0-5	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	11-25
	5-15	Clay, silty clay, silty clay loam.	MH, CH	A-7	0	100	100	95-100	90-100	60-90	30-50
	15-50	Silty clay loam, silty clay, clay loam.	CH, MH	A-7	0	100	100	95-100	85-100	50-80	20-45
	50-60	Silty clay loam, silt loam, clay loam.	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
86*:											
Overly----------	0-8	Silt loam--------	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	85-100	25-45	5-25
	8-37	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	37-60	Stratified very fine sandy loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
Nahon-----------	0-7	Silt loam--------	CL, ML	A-6, A-7	0	100	100	90-100	80-100	30-45	10-20
	7-17	Silty clay, silty clay loam.	MH, CH, CL, ML	A-7	0	100	100	95-100	90-100	45-65	15-35
	17-38	Silty clay, silty clay loam.	CL, CH, MH, ML	A-7	0	100	100	95-100	85-100	40-65	15-30
	38-60	Stratified very fine sandy loam, loam, silt loam.	CL, CH, ML, MH	A-7	0	100	100	90-100	75-100	40-70	15-35
87*:											
Svea------------	0-12	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	12-25	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	25-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30
Cavour----------	0-9	Loam------------	ML, CL, MH	A-4, A-6, A-7	0	100	95-100	85-100	60-85	30-55	5-20
	9-19	Clay, clay loam, silty clay loam.	CL, CH, MH, ML	A-7	0	100	95-100	90-100	70-85	40-65	15-30
	19-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-100	60-85	35-65	12-35
88*:											
Manfred---------	0-5	Extremely stony silt loam.	CL, CL-ML	A-4, A-6	3-25	100	100	85-95	60-75	20-40	5-15
	5-60	Loam, silty clay loam, clay loam.	CL, CH	A-6, A-7	0-15	85-100	85-100	85-100	50-95	25-55	10-35

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
88*:											
Vallers	0-7	Extremely stony loam.	ML, CL-ML, CL	A-4, A-6, A-7	3-20	95-100	90-100	80-100	60-95	20-45	5-25
	7-32	Clay loam, loam, silty clay loam.	ML, CL-ML, CL	A-4, A-6, A-7	0-5	95-100	90-100	80-100	60-95	20-45	5-25
	32-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-95	20-45	5-25
89 Fordville	0-7	Loam	ML, CL	A-4, A-6, A-7	0	100	100	70-85	55-75	30-45	5-20
	7-21	Loam, silt loam, clay loam.	CL, ML	A-4, A-6, A-7	0	100	95-100	70-95	55-80	30-45	5-20
	21-33	Loam, clay loam, fine sandy loam.	CL, ML, SM, SC	A-4, A-6	0	95-100	90-100	65-90	40-55	25-40	3-15
	33-60	Gravelly loamy sand, sand, very gravelly sand.	SW, SW-SM, SM	A-1	0	65-85	45-70	15-45	0-15	<25	NP-5
90 Dovray	0-20	Silty clay	CH, MH, OH	A-7	0	100	100	95-100	85-95	50-80	25-40
	20-45	Clay, silty clay	CH, MH	A-7	0	100	100	95-100	85-95	50-75	25-40
	45-60	Clay, silty clay	CH, MH	A-7	0	100	95-100	90-100	85-95	50-80	25-40
91 Arveson	0-15	Loam	ML	A-4	0-1	100	95-100	85-90	50-80	25-40	NP-10
	15-36	Fine sandy loam, sandy loam, loam.	SM, SM-SC	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	36-48	Loamy fine sand, loamy sand, sandy loam.	SP-SM, SM, SM-SC	A-3, A-2, A-4	0	100	95-100	50-80	5-45	<20	NP-5
	48-60	Clay loam, loam	CL	A-7	0	100	90-100	75-95	50-75	40-50	15-25
92B*:											
Barnes	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-40	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	40-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Cavour	0-9	Loam	ML, CL, MH	A-4, A-6, A-7	0	100	95-100	85-100	60-85	30-55	5-20
	9-19	Clay, clay loam, silty clay loam.	CL, CH, MH, ML	A-7	0	100	95-100	90-100	70-85	40-65	15-30
	19-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-100	60-85	35-65	12-35
98B*:											
Barnes	0-7	Extremely stony loam.	CL	A-6	3-25	90-100	85-100	80-100	60-75	25-40	10-20
	7-15	Loam, clay loam, stony loam.	CL, CL-ML	A-4, A-6	0-20	90-100	85-100	75-95	60-80	25-40	5-20
	15-60	Loam, clay loam, stony loam.	CL, CL-ML	A-4, A-6	0-15	90-100	85-100	75-95	60-80	25-40	5-20
Svea	0-12	Extremely stony loam.	CL, CL-ML	A-4, A-6	3-25	95-100	85-100	80-95	60-90	20-40	5-25
	12-25	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-10	95-100	85-100	80-95	60-90	20-45	5-25
	25-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-10	95-100	85-100	80-95	60-85	20-50	5-30

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
2---------------- Tonka	0-18	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low-------	0.32	5	6
	18-39	0.06-0.2	0.14-0.19	5.6-7.8	<2	High------	0.43		
	39-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
3---------------- Parnell	0-8	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
	8-35	0.06-0.2	0.13-0.19	6.1-7.8	<2	High------	0.28		
	35-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
6---------------- Southam	0-24	0.2-0.6	0.18-0.23	6.6-8.4	2-8	Moderate	0.37	5	4
	24-49	0.06-0.2	0.14-0.20	6.6-8.4	2-8	High------	0.28		
	49-60	0.06-0.6	0.13-0.17	7.4-9.0	2-8	High------	0.28		
9, 9B, 9D-------- Nutley	0-8	0.06-0.2	0.10-0.16	6.6-8.4	<2	High------	0.28	5	4
	8-60	0.06-0.2	0.08-0.15	7.4-8.4	<2	High------	0.28		
12*:									
Lismore---------	0-11	0.6-2.0	0.19-0.22	6.1-7.3	<2	Moderate	0.28	5	7
	11-20	0.6-2.0	0.19-0.22	6.1-7.3	<2	Moderate	0.28		
	20-40	0.2-0.6	0.18-0.22	6.6-7.8	<4	Moderate	0.28		
	40-60	0.2-0.6	0.16-0.18	7.4-8.4	<4	Moderate	0.37		
Kranzburg-------	0-8	0.6-2.0	0.19-0.22	5.6-7.3	<2	Moderate	0.32	5	7
	8-19	0.6-2.0	0.18-0.21	6.6-7.8	<2	Moderate	0.32		
	19-34	0.2-0.6	0.16-0.20	7.4-9.0	<4	Moderate	0.32		
	34-60	0.2-0.6	0.16-0.20	7.4-9.0	<8	Moderate	0.32		
13B*:									
Kranzburg-------	0-8	0.6-2.0	0.19-0.22	5.6-7.3	<2	Moderate	0.32	5	7
	8-19	0.6-2.0	0.18-0.21	6.6-7.8	<2	Moderate	0.32		
	19-34	0.2-0.6	0.16-0.20	7.4-9.0	<4	Moderate	0.32		
	34-60	0.2-0.6	0.16-0.20	7.4-9.0	<8	Moderate	0.32		
Lismore---------	0-11	0.6-2.0	0.19-0.22	6.1-7.3	<2	Moderate	0.28	5	7
	11-20	0.6-2.0	0.19-0.22	6.1-7.3	<2	Moderate	0.28		
	20-40	0.2-0.6	0.18-0.22	6.6-7.8	<4	Moderate	0.28		
	40-60	0.2-0.6	0.16-0.18	7.4-8.4	<4	Moderate	0.37		
14B*, 14C*, 14D*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Buse------------	0-6	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	4L
	6-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
15*:									
Swenoda---------	0-8	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low-------	0.20	5	3
	8-34	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low-------	0.20		
	34-60	0.2-2.0	0.17-0.20	6.6-8.4	<4	Moderate	0.37		
Lanona----------	0-8	2.0-6.0	0.13-0.18	6.1-7.3	<2	Low-------	0.20	5	3
	8-28	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low-------	0.24		
	28-60	0.2-2.0	0.16-0.20	7.4-8.4	<4	Moderate	0.32		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
15B*:									
Lanona----------	0-8	2.0-6.0	0.13-0.18	6.1-7.3	<2	Low-------	0.20	5	3
	8-28	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low-------	0.24		
	28-60	0.2-2.0	0.16-0.20	7.4-8.4	<4	Moderate	0.32		
Swenoda---------	0-8	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low-------	0.20	5	3
	8-34	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low-------	0.20		
	34-60	0.2-2.0	0.17-0.20	6.6-8.4	<4	Moderate	0.37		
15C------------- Lanona	0-8	2.0-6.0	0.13-0.18	6.1-7.3	<2	Low-------	0.20	5	3
	8-28	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low-------	0.24		
	28-60	0.2-2.0	0.16-0.20	7.4-8.4	<4	Moderate	0.32		
16B*, 16C*, 16E*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Sioux-----------	0-6	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low-------	0.28	2	5
	6-8	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low-------	0.20		
	8-60	>6.0	0.03-0.06	7.4-8.4	<2	Low-------	0.10		
17B*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Svea------------	0-12	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	12-25	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	25-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
18-------------- Bearden	0-9	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L
	9-32	0.2-2.0	0.16-0.22	7.4-8.4	<4	Moderate	0.28		
	32-46	0.2-0.6	0.16-0.22	7.4-8.4	<4	Moderate	0.43		
	46-60	0.2-0.6	0.16-0.22	7.4-8.4	<8	Moderate	0.43		
19-------------- Colvin	0-8	0.2-0.6	0.13-0.16	7.4-9.0	4-16	Moderate	0.32	5	4L
	8-60	0.2-0.6	0.11-0.15	7.4-9.0	4-16	Moderate	0.32		
23F*:									
Buse------------	0-6	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	4L
	6-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
26-------------- Colvin	0-11	0.2-0.6	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
	11-31	0.06-2.0	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	31-60	0.2-0.6	0.15-0.20	7.4-9.0	<2	Moderate	0.32		
27-------------- Divide	0-11	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low-------	0.28	4	4L
	11-28	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low-------	0.28		
	28-60	>20	0.03-0.07	7.4-8.4	<2	Low-------	0.10		
31B------------- Egeland	0-9	2.0-6.0	0.11-0.17	5.6-7.3	<2	Low-------	0.20	5	3
	9-40	2.0-6.0	0.09-0.15	6.1-7.8	<2	Low-------	0.20		
	40-60	2.0-6.0	0.08-0.10	6.6-8.4	<2	Low-------	0.20		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
36----------------Fargo	0-8	0.06-0.2	0.15-0.18	6.6-7.8	<2	High-------	0.32	5	4
	8-19	0.06-0.2	0.14-0.17	6.6-8.4	<2	High-------	0.32		
	19-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High-------	0.32		
40B*:									
Gardena----------	0-24	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	5
	24-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43		
Zell-------------	0-8	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.32	5	4L
	8-23	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low--------	0.43		
	23-60	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low--------	0.43		
40C, 40E---------Zell	0-8	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.32	5	4L
	8-23	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low--------	0.43		
	23-60	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low--------	0.43		
43----------------Gardena	0-24	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	5
	24-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43		
46*:									
Gardena----------	0-24	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	5
	24-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43		
Glyndon----------	0-11	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low--------	0.28	5	4L
	11-50	0.6-2.0	0.17-0.20	7.4-9.0	<4	Low--------	0.28		
	50-60	0.6-2.0	0.15-0.19	7.4-9.0	<4	Low--------	0.28		
48----------------Glyndon	0-11	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low--------	0.28	5	4L
	11-50	0.6-2.0	0.17-0.20	7.4-9.0	<4	Low--------	0.28		
	50-60	0.6-2.0	0.15-0.19	7.4-9.0	<4	Low--------	0.28		
49----------------Glyndon	0-9	0.6-2.0	0.13-0.15	7.4-9.0	4-16	Low--------	0.28	5	4L
	9-60	0.6-2.0	0.11-0.13	7.9-9.0	4-16	Low--------	0.28		
50*:									
Hamerly----------	0-7	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	7-37	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	37-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Tonka------------	0-18	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low--------	0.32	5	6
	18-39	0.06-0.2	0.14-0.19	5.6-7.8	<2	High-------	0.43		
	39-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
54----------------Lamoure	0-16	0.2-2.0	0.19-0.22	7.4-8.4	<4	Moderate	0.28	5	4L
	16-40	0.2-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28		
	40-60	0.2-2.0	0.09-0.18	7.4-8.4	<4	Low--------	0.28		
56----------------LaDelle	0-11	0.6-2.0	0.19-0.22	6.6-7.8	<2	Moderate	0.28	5	7
	11-30	0.6-2.0	0.18-0.22	7.4-8.4	<4	Moderate	0.28		
	30-60	0.6-2.0	0.18-0.22	7.4-8.4	<4	Moderate	0.28		
62*:									
Overly-----------	0-8	0.2-0.6	0.17-0.23	6.6-7.8	<2	Moderate	0.32	5	7
	8-37	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.32		
	37-60	0.06-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		
Bearden----------	0-9	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L
	9-32	0.2-2.0	0.16-0.22	7.4-8.4	<4	Moderate	0.28		
	32-46	0.2-0.6	0.16-0.22	7.4-8.4	<4	Moderate	0.43		
	46-60	0.2-0.6	0.16-0.22	7.4-8.4	<8	Moderate	0.43		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
63--------------- Renshaw	0-8	0.6-2.0	0.18-0.20	6.1-7.8	<2	Low--------	0.28	3	6
	8-16	0.6-6.0	0.11-0.18	6.6-8.4	<2	Low--------	0.28		
	16-60	>6.0	0.03-0.06	6.6-8.4	<2	Low--------	0.10		
64*. Pits									
65*:									
Svea------------	0-12	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	12-25	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	25-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low--------	0.28	5	6
	7-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
66*:									
Hamerly---------	0-7	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	7-37	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	37-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Wyard-----------	0-30	0.6-2.0	0.20-0.24	6.6-7.8	<2	Moderate	0.28	5	6
	30-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
66B-------------- Hamerly	0-7	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	7-37	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	37-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
67C*:									
Renshaw---------	0-8	0.6-2.0	0.18-0.20	6.1-7.8	<2	Low--------	0.28	3	6
	8-16	0.6-6.0	0.11-0.18	6.6-8.4	<2	Low--------	0.28		
	16-60	>6.0	0.03-0.06	6.6-8.4	<2	Low--------	0.10		
Sioux-----------	0-6	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low--------	0.28	2	5
	6-8	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20		
	8-60	>6.0	0.03-0.06	7.4-8.4	<2	Low--------	0.10		
68E*:									
Sioux-----------	0-6	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low--------	0.28	2	5
	6-8	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20		
	8-60	>6.0	0.03-0.06	7.4-8.4	<2	Low--------	0.10		
Renshaw---------	0-8	0.6-2.0	0.18-0.20	6.1-7.8	<2	Low--------	0.28	3	6
	8-16	0.6-6.0	0.11-0.18	6.6-8.4	<2	Low--------	0.28		
	16-60	>6.0	0.03-0.06	6.6-8.4	<2	Low--------	0.10		
71*:									
Vallers---------	0-7	0.6-2.0	0.22-0.24	7.4-8.4	<4	Low--------	0.28	5	4L
	7-32	0.2-0.6	0.15-0.19	7.4-8.4	<4	Moderate	0.28		
	32-60	0.2-0.6	0.17-0.19	7.4-8.4	<4	Low--------	0.28		
Parnell---------	0-8	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
	8-35	0.06-0.2	0.13-0.19	6.1-7.8	<2	High------	0.28		
	35-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
77--------------- Vallers	0-11	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low--------	0.28	5	4L
	11-35	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Low--------	0.28		
	35-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low--------	0.28		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
80---------------- Marysland	0-8	0.6-2.0	0.17-0.22	7.9-8.4	<2	Moderate	0.28	4	4L
	8-34	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.28		
	34-60	>6.0	0.02-0.07	7.9-8.4	<2	Low-------	0.15		
81B--------------- Edgeley	0-8	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low-------	0.28	4	6
	8-32	0.6-2.0	0.13-0.19	6.1-8.4	<2	Moderate	0.28		
	32-60	---	---	---	---	----------	----		
82, 82B---------- Sinai	0-9	0.06-0.2	0.17-0.19	6.1-7.3	<2	High------	0.28	5	7
	9-18	0.06-0.2	0.17-0.19	6.6-7.8	<2	High------	0.28		
	18-49	0.06-0.2	0.11-0.17	7.4-8.4	<2	High------	0.28		
	49-60	0.06-0.2	0.11-0.17	7.4-8.4	<2	High------	0.43		
83F*:									
Kloten----------	0-5	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.32	2	7
	5-16	0.6-2.0	0.05-0.19	6.1-8.4	<2	Moderate	0.10		
	16-60	---	---	---	---	----------	----		
Buse------------	0-6	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	4L
	6-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
84---------------- Easby	0-16	0.6-2.0	0.03-0.05	7.4-9.0	>16	Moderate	0.28	5	4L
	16-60	0.2-0.6	0.07-0.10	7.4-9.0	>8	Moderate	0.28		
85---------------- Exline	0-5	0.2-0.6	0.19-0.22	6.1-7.8	<2	Moderate	0.37	3	7
	5-15	<0.06	0.10-0.15	6.6-9.0	4-16	High------	0.28		
	15-50	0.06-0.2	0.14-0.17	7.9-9.0	4-8	High------	0.43		
	50-60	0.06-0.2	0.14-0.17	7.9-9.0	2-8	Moderate	0.43		
86*:									
Overly----------	0-8	0.2-0.6	0.22-0.24	6.6-7.8	<2	Moderate	0.32	5	6
	8-37	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.32		
	37-60	0.06-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		
Nahon-----------	0-7	0.2-0.6	0.19-0.22	5.6-7.3	<2	Moderate	0.28	3	6
	7-17	<0.06	0.10-0.15	6.6-9.0	<2	High------	0.28		
	17-38	0.06-0.2	0.11-0.19	7.4-9.0	4-16	High------	0.28		
	38-60	<0.6	0.14-0.17	7.9-9.0	4-16	Moderate	0.43		
87*:									
Svea------------	0-12	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	12-25	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	25-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Cavour----------	0-9	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	9-19	<0.2	0.10-0.16	6.6-9.0	4-16	High------	0.37		
	19-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
88*:									
Manfred---------	0-5	0.06-0.2	0.20-0.22	6.1-8.4	2-4	Moderate	0.32	3	8
	5-60	0.06-0.2	0.17-0.23	7.9-9.0	2-16	High------	0.32		
Vallers---------	0-7	0.6-2.0	0.17-0.22	6.6-8.4	<4	Moderate	0.28	5	8
	7-32	0.2-2.0	0.15-0.19	7.4-8.4	<4	Moderate	0.28		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.28		
89---------------- Fordville	0-7	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low-------	0.24	4	6
	7-21	0.6-2.0	0.18-0.21	6.1-7.8	<2	Moderate	0.24		
	21-33	0.6-6.0	0.12-0.18	6.1-8.4	<2	Low-------	0.24		
	33-60	6.0-20	0.03-0.06	7.4-8.4	<2	Low-------	0.10		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
90----------------	0-20	0.06-0.6	0.14-0.18	6.1-7.8	<2	High------	0.28	5	4
Dovray	20-45	0.06-0.2	0.13-0.16	6.1-7.8	<2	High------	0.28		
	45-60	<0.2	0.10-0.14	6.6-8.4	<2	High------	0.28		
91----------------	0-15	0.6-2.0	0.16-0.18	7.4-8.4	<2	Low-------	0.24	4	4L
Arveson	15-36	0.6-6.0	0.15-0.17	7.4-8.4	<2	Low-------	0.24		
	36-48	2.0-20	0.05-0.15	7.4-8.4	<2	Low-------	0.17		
	48-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate	0.24		
92B*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-40	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	40-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Cavour----------	0-9	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	9-19	<0.2	0.10-0.16	6.6-9.0	4-16	High------	0.37		
	19-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
98B*:									
Barnes----------	0-7	0.6-2.0	0.20-0.22	5.6-7.8	<2	Low-------	0.20	5	8
	7-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Low-------	0.32		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Low-------	0.32		
Svea------------	0-12	0.6-2.0	0.20-0.22	6.1-7.8	<2	Low-------	0.28	5	8
	12-25	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	25-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "long," "brief," "apparent," and "perched" are explained in the te
< means less than; > means more than. Absence of an entry indicates that the feature is not a concern or tha
estimated)

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Ri
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Unc s
					Ft			In			
2----------------- Tonka	C/D	None---------	---	---	+.5-1.0	Apparent	Apr-Jun	>60	---	High-----	Hig
3----------------- Parnell	C/D	None---------	---	---	+2-2.0	Apparent	Jan-Dec	>60	---	High-----	Hig
6----------------- Southam	D	None---------	---	---	+5-1.0	Apparent	Jan-Dec	>60	---	High-----	Hig
9, 9B, 9D--------- Nutley	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	Hig
12*:											
Lismore----------	B	None---------	---	---	4.0-6.0	Perched	Oct-Jun	>60	---	High-----	Hig
Kranzburg--------	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Hig
13B*:											
Kranzburg--------	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Hig
Lismore----------	B	None---------	---	---	4.0-6.0	Perched	Oct-Jun	>60	---	High-----	Hig
14B*, 14C*, 14D*:											
Barnes-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Hig
Buse-------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low
15*:											
Swenoda----------	B	None---------	---	---	2.5-4.0	Perched	Mar-Jun	>60	---	Moderate	Hig
Lanona-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Hig
15B*:											
Lanona-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Hig
Swenoda----------	B	None---------	---	---	2.5-4.0	Perched	Mar-Jun	>60	---	Moderate	Hig
15C--------------- Lanona	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Hig
16B*, 16C*, 16E*:											
Barnes-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Hig

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Ri
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Unc s
					Ft			In			
16B*, 16C*, 16E*:											
Sioux	A	None	---	---	>6.0	---	---	>60	---	Low	Low
17B*:											
Barnes	B	None	---	---	>6.0	---	---	>60	---	Moderate	Hig
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	Hig
18 Bearden	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High	Hig
19 Colvin	C	Occasional	Long	Apr-Jun	0-2.0	Apparent	Apr-Jul	>60	---	High	Hig
23F*:											
Buse	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low
Barnes	B	None	---	---	>6.0	---	---	>60	---	Moderate	Hig
26 Colvin	C/D	None	---	---	0-1.0	Apparent	Apr-Jul	>60	---	High	Hig
27 Divide	B	None	---	---	2.5-5.0	Apparent	Apr-Jun	>60	---	Moderate	Hig
31B Egeland	B	None	---	---	>6.0	---	---	>60	---	Low	Mod
36 Fargo	D	None	---	---	0-3.0	Apparent	Sep-Jun	>60	---	High	Hig
40B*:											
Gardena	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	High	Mod
Zell	B	None	---	---	>6.0	---	---	>60	---	High	Hig
40C, 40E Zell	B	None	---	---	>6.0	---	---	>60	---	High	Hig
43 Gardena	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	High	Mod
46*:											
Gardena	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	High	Mod
Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	>60	---	High	Hig
48 Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	>60	---	High	Hig

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Ri
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Unc s
					Ft			In			
49---------------- Glyndon	B	None---------	---	---	2.5-6.0	Apparent	Apr-Jul	>60	---	High-----	Hig
50*:											
Hamerly-----------	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High-----	Hig
Tonka-------------	C/D	None---------	---	---	+.5-1.0	Apparent	Apr-Jun	>60	---	High-----	Hig
54---------------- Lamoure	C	Frequent----	Brief-----	Mar-Oct	0-2.0	Apparent	Oct-Jun	>60	---	High-----	Hig
56---------------- LaDelle	B	Occasional	Brief-----	Apr-Jun	4.0-6.0	Apparent	Oct-Jun	>60	---	High-----	Hig
62*:											
Overly------------	C	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	High-----	Hig
Bearden-----------	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High-----	Hig
63---------------- Renshaw	B	None---------	---	---	>6.0	---	---	>60	---	Low------	Mod
64*. Pits											
65*:											
Svea--------------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	Hig
Barnes------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Hig
66*:											
Hamerly-----------	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High-----	Hig
Wyard-------------	B	None---------	---	---	1.0-3.0	Apparent	Mar-Jun	>60	---	High-----	Hig
66B--------------- Hamerly	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High-----	Hig
67C*:											
Renshaw-----------	B	None---------	---	---	>6.0	---	---	>60	---	Low------	Mod
Sioux-------------	A	None---------	---	---	>6.0	---	---	>60	---	Low------	Low
68E*:											
Sioux-------------	A	None---------	---	---	>6.0	---	---	>60	---	Low------	Low
Renshaw-----------	B	None---------	---	---	>6.0	---	---	>60	---	Low------	Mod

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Ri
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Unc s
					Ft			In			
71*:											
Vallers	C	None	---	---	1.0-2.5	Apparent	Nov-Jun	>60	---	High	Hig
Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	>60	---	High	Hig
77 Vallers	C	None	---	---	0-1.0	Apparent	Apr-Jul	>60	---	High	Hig
80 Marysland	B/D	Rare	---	---	1.0-2.5	Apparent	Nov-Jul	>60	---	High	Hig
81B Edgeley	C	None	---	---	>6.0	---	---	20-40	Soft	Moderate	Hig
82, 82B Sinai	C	None	---	---	>6.0	---	---	>60	---	Low	Hig
83F*:											
Kloten	D	None	---	---	>6.0	---	---	9-20	Soft	Moderate	Hig
Buse	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low
84 Easby	D	None	---	---	0-1.0	Apparent	Sep-Jun	>60	---	High	Hig
85 Exline	D	None	---	---	2.5-4.0	Apparent	Apr-Jun	>60	---	Moderate	Hig
86*:											
Overly	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	High	Hig
Nahon	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	Hig
87*:											
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	Hig
Cavour	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	Hig
88*:											
Manfred	D	None	---	---	+1-1.0	Apparent	Mar-Aug	>60	---	High	Hig
Vallers	C	None	---	---	1.0-2.5	Apparent	Nov-Jun	>60	---	High	Hig
89 Fordville	B	None	---	---	>6.0	---	---	>60	---	Low	Mod
90 Dovray	C/D	None	---	---	+2-1.0	Apparent	Jan-Dec	>60	---	Moderate	Hig

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Ri
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Unc s
					Ft			In			
91---------------- Arveson	B/D	None---------	---	---	0-2.0	Apparent	Apr-Jul	>60	---	High------	Hig
92B*:											
Barnes-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Hig
Cavour-----------	D	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	Hig
98B*:											
Barnes-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Hig
Svea-------------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	Hig

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

(Dashes indicate data were not available. LL means liquid limit; PI, plasticity index; MD, maximum dry density; OM, optimum moisture; and NP, nonplastic]

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ft3	Pct
Gardena silt loam: (S82ND-003-1)														
A2------ 10 to 24	A-6(10)	ML	100	100	100	100	83	---	19	---	37	12	110	16
C1------ 44 to 54	A-4(11)	ML	100	100	100	100	97	---	22	---	34	10	109	16
Glyndon silt loam: (S83ND-003-31)														
C2------ 41 to 50	A-4(9)	ML	100	100	100	100	99	---	21	---	36	7	106	18
Kranzburg silty clay loam: (S85ND-003-31)														
Bt2----- 11 to 19	A-7-6(20)	CL	100	100	100	97	82	---	48	---	47	23	108	17
C2------ 43 to 60	A-6(11)	CL	97	95	92	85	70	---	36	---	38	17	117	14
LaDelle silty clay loam: (S84ND-003-24)														
Bw------ 11 to 17	A-7-6(22)	CL	100	100	100	100	86	---	40	---	49	24	101	20
C------- 30 to 60	A-7-6(13)	ML	100	100	100	99	75	---	36	---	43	17	104	18
Lanona fine sandy loam: (S84ND-003-19)														
Bw1----- 7 to 13	A-4(0)	SM	100	100	100	97	37	---	14	---	27	7	115	14
2C------ 46 to 60	A-6(5)	CL	99	98	94	85	62	---	25	---	32	11	112	15
Lismore silty clay loam: (S84ND-003-17)														
Bt1----- 11 to 20	A-7-6(23)	CL	100	100	100	98	90	---	55	---	47	24	106	18
C------- 40 to 60	A-6(6)	CL	99	97	92	83	62	---	27	---	36	12	114	14
Nutley silty clay: (S83ND-003-17)														
Bw2----- 15 to 25	A-7-6(42)	CH	100	100	100	93	89	---	72	---	68	42	106	18
C1------ 36 to 52	A-7-6(54)	CH	100	100	100	99	97	---	84	---	77	47	106	18

TABLE 17.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ft3	Pct
Sinai silty clay loam: (S84ND-003-9)														
Bw------ 9 to 18	A-7-6(33)	CH	100	100	100	100	96	---	50	---	62	27	91	24
C2------ 49 to 60	A-7-6(42)	CH	100	100	100	100	98	---	72	---	62	37	103	19
Swenoda fine sandy loam: (S84ND-003-20)														
Bw1----- 7 to 18	A-4(0)	SP-SM	100	100	100	96	36	---	16	---	25	5	118	13
2C------ 50 to 60	A-6(5)	CL	99	97	91	80	57	---	21	---	34	12	114	15

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Arveson	Coarse-loamy, frigid Typic Calciaquolls
Barnes	Fine-loamy, mixed Udic Haploborolls
Bearden	Fine-silty, frigid Aeric Calciaquolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Cavour	Fine, montmorillonitic Udic Natriborolls
Colvin	Fine-silty, frigid Typic Calciaquolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Dovray	Fine, montmorillonitic, frigid Cumulic Haplaquolls
Easby	Fine-loamy, frigid Typic Calciaquolls
Edgeley	Fine-loamy, mixed Udic Haploborolls
Egeland	Coarse-loamy, mixed Udic Haploborolls
Exline	Fine, montmorillonitic Leptic Natriborolls
Fargo	Fine, montmorillonitic, frigid Vertic Haplaquolls
Fordville	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Udic Haploborolls
Gardena	Coarse-silty, mixed Pachic Udic Haploborolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Kloten	Loamy, mixed Lithic Haploborolls
Kranzburg	Fine-silty, mixed Udic Haploborolls
LaDelle	Fine-silty, mixed Cumulic Udic Haploborolls
Lamoure	Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls
Lanona	Coarse-loamy, mixed Udic Haploborolls
Lismore	Fine-loamy, mixed Pachic Udic Haploborolls
Manfred	Fine-loamy, mixed, frigid Typic Natraquolls
Marysland	Fine-loamy over sandy or sandy-skeletal, frigid Typic Calciaquolls
Nahon	Fine, montmorillonitic Udic Natriborolls
Nutley	Fine, montmorillonitic Udertic Haploborolls
Overly	Fine-silty, mixed Pachic Udic Haploborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Renshaw	Fine-loamy over sandy or sandy-skeletal, mixed Udic Haploborolls
Sinai	Fine, montmorillonitic Udertic Haploborolls
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Southam	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Swenoda	Coarse-loamy, mixed Pachic Udic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Wyard	Fine-loamy, mixed, frigid Typic Haplaquolls
Zell	Coarse-silty, mixed Udorthentic Haploborolls

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To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081.wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for

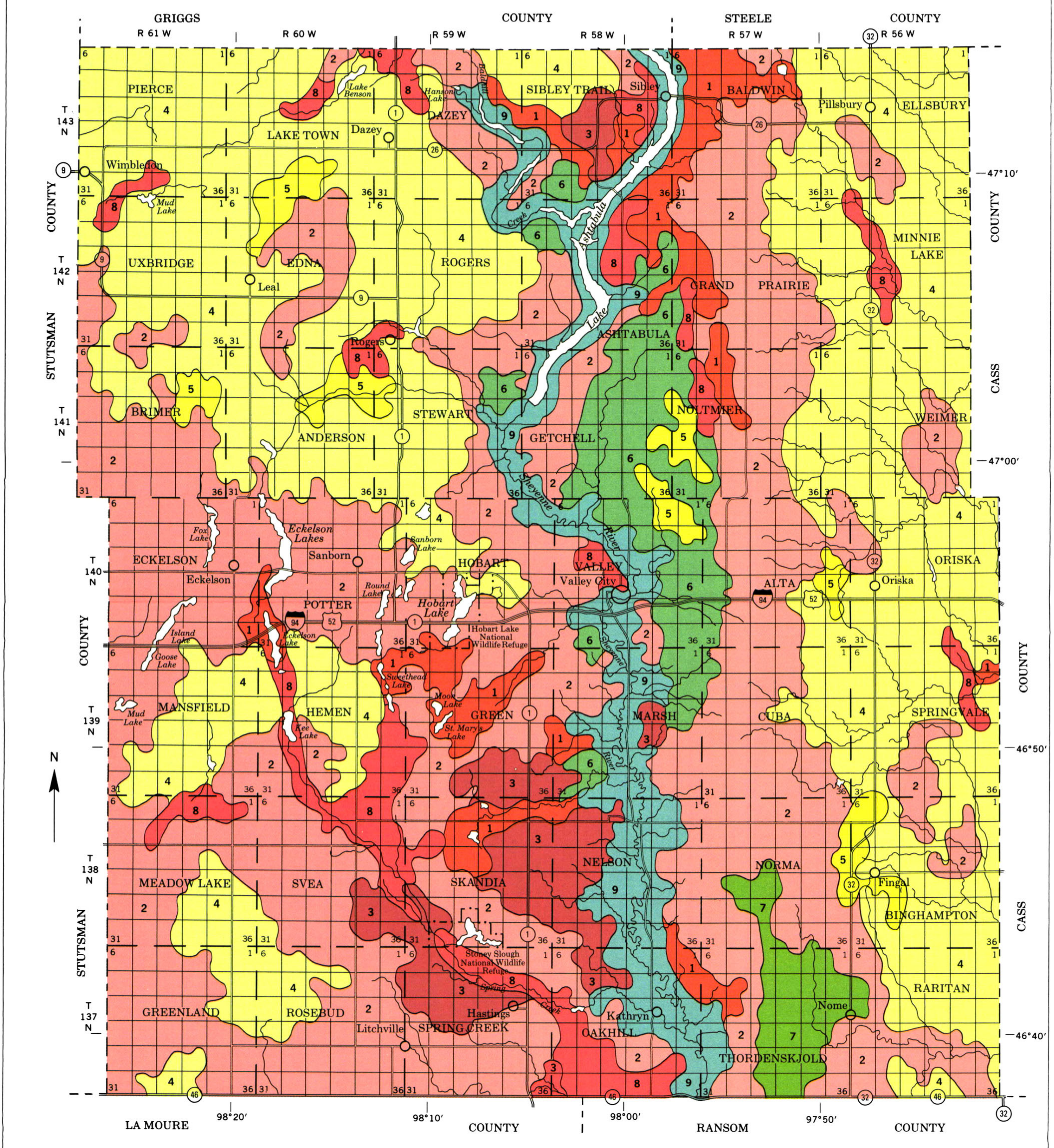
program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).



SOIL LEGEND*

LEVEL TO STEEP, LOAMY SOILS ON GLACIAL TILL PLAINS AND MORAINES

1 — Barnes-Buse-Svea association: Deep, undulating to steep, well drained and moderately well drained, medium textured soils

2 — Barnes-Svea-Buse association: Deep, level to rolling, well drained and moderately well drained, medium textured soils

3 — Svea-Cavour-Barnes association: Deep, level to undulating, moderately well drained and well drained, medium textured soils

LEVEL TO UNDULATING, LOAMY AND SILTY SOILS ON GLACIAL TILL PLAINS AND IN GLACIAL OUTWASH CHANNELS

4 — Hamerly-Tonka-Barnes association: Deep, level to undulating, somewhat poorly drained, poorly drained, and well drained, medium textured soils

5 — Southam-Vallers association: Deep, level, poorly drained and very poorly drained, medium textured and moderately fine textured soils

LEVEL TO GENTLY SLOPING, SILTY AND CLAYEY SOILS ON TILL PLAINS AND LAKE PLAINS

6 — Gardena-Glyndon-Overly association: Deep, level to gently sloping, moderately well drained and somewhat poorly drained, medium textured and moderately fine textured soils

7 — Kranzburg-Lismore-Fargo association: Deep, level to undulating, well drained, moderately well drained, and poorly drained, moderately fine textured and fine textured soils

LEVEL TO MODERATELY STEEP, LOAMY SOILS ON OUTWASH PLAINS AND TERRACES

8 — Renshaw-Divide-Fordville association: Deep, level to moderately steep, somewhat excessively drained, somewhat poorly drained, and well drained, medium textured soils

LEVEL TO STEEP, LOAMY, SILTY, AND CLAYEY SOILS IN STREAM VALLEYS

9 — Buse-Barnes-Nutley-Kloten association: Shallow and deep, level to steep, well drained, fine textured, medium textured, and moderately fine textured soils

*The texture terms in the descriptive headings refer to the surface layer of the major soils in the associations.

Compiled 1988

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA COOPERATIVE EXTENSION SERVICE
NORTH DAKOTA STATE SOIL CONSERVATION COMMITTEE

GENERAL SOIL MAP

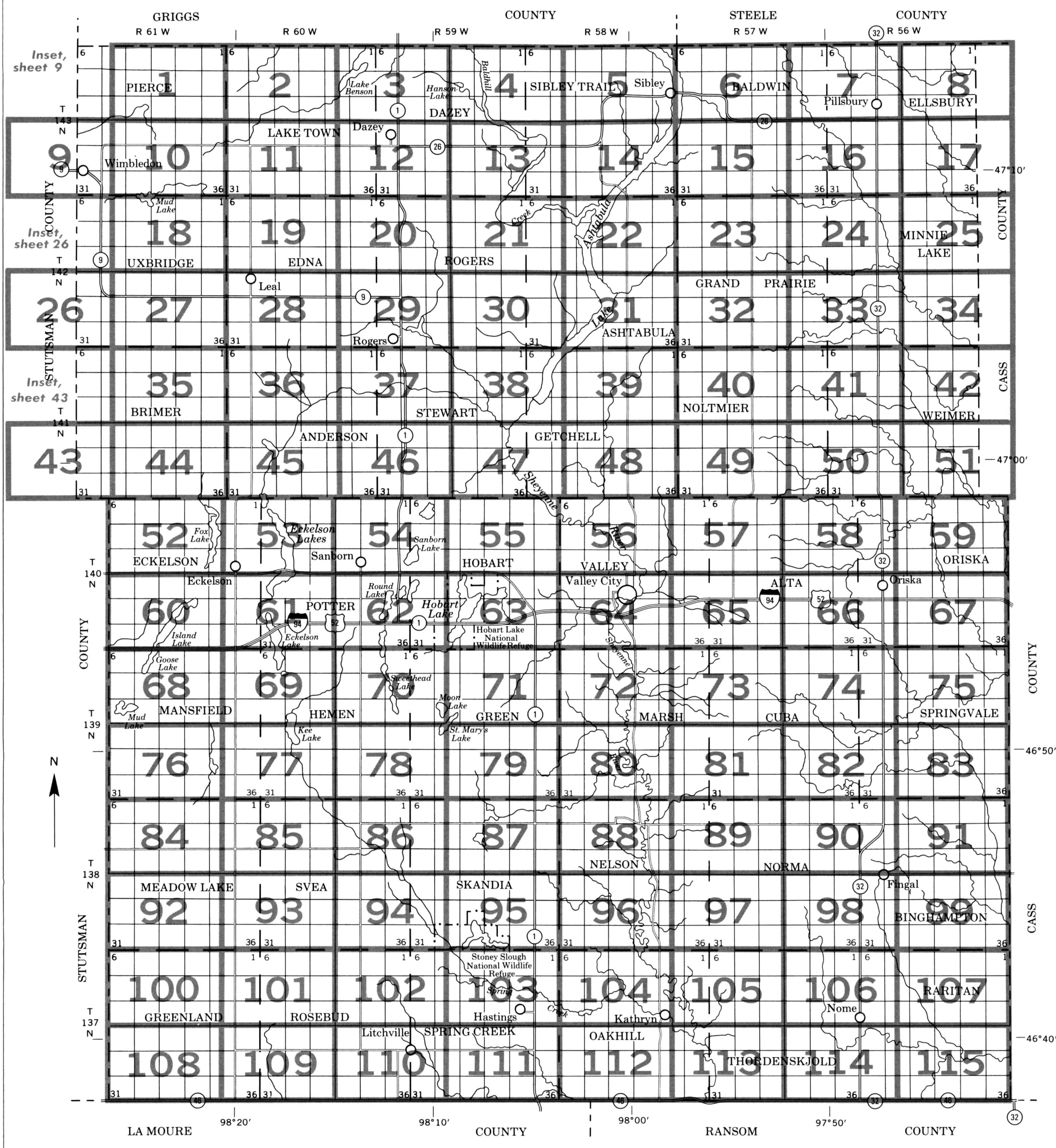
BARNES COUNTY, NORTH DAKOTA

Scale 1:253,440

1 0 1 2 3 4 Mi

1 0 4 8 Km

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

BARNES COUNTY, NORTH DAKOTA

Scale 1:253,440

1 0 1 2 3 4 Mi

1 0 4 8 Km

SOIL LEGEND

Symbols consist of numbers or a combination of numbers and a letter. The initial numbers designate the kind of soil. A capital letter following the numbers indicate the class of slope. Symbols without a slope letter are for level or nearly level soils.

SYMBOL	NAME
2	Tonka silt loam
3	Parnell silty clay loam
6	Southam silty clay loam
9	Nutley silty clay, 0 to 2 percent slopes
9B	Nutley silty clay, 2 to 6 percent slopes
9D	Nutley silty clay, 6 to 15 percent slopes
12	Lismore-Kranzburg silty clay loams, 0 to 2 percent slopes
13B	Kranzburg-Lismore silty clay loams, 2 to 6 percent slopes
14B	Barnes-Buse loams, 3 to 6 percent slopes
14C	Barnes-Buse loams, 6 to 9 percent slopes
14D	Barnes-Buse loams, 9 to 15 percent slopes
15	Swenoda-Lanona fine sandy loams, 0 to 2 percent slopes
15B	Lanona-Swenoda fine sandy loams, 2 to 6 percent slopes
15C	Lanona fine sandy loam, 6 to 9 percent slopes
16B	Barnes-Sioux loams, 1 to 6 percent slopes
16C	Barnes-Sioux loams, 6 to 9 percent slopes
16E	Barnes-Sioux loams, 9 to 25 percent slopes
17B	Barnes-Svea loams, 2 to 6 percent slopes
18	Bearden silty clay loam
19	Colvin silty clay loam, saline
23F	Buse-Barnes loams, 15 to 35 percent slopes
26	Colvin silty clay loam
27	Divide loam
31B	Egeland fine sandy loam, 1 to 6 percent slopes
36	Fargo silty clay
40B	Gardena-Zell silt loams, 3 to 6 percent slopes
40C	Zell silt loam, 6 to 9 percent slopes
40E	Zell silt loam, 9 to 25 percent slopes
43	Gardena silt loam
46	Gardena-Glyndon silt loams, 0 to 3 percent slopes
48	Glyndon silt loam
49	Glyndon silt loam, saline, 0 to 3 percent slopes
50	Hamerly-Tonka complex, 0 to 3 percent slopes
54	Lamoure silt loam, channeled
56	LaDelle silty clay loam
62	Overly-Bearden silty clay loams
63	Renshaw loam, 0 to 2 percent slopes
64	Pits, gravel
65	Svea-Barnes loams, 0 to 2 percent slopes
66	Hamerly-Wyard loams, 0 to 3 percent slopes
66B	Hamerly loam, 3 to 6 percent slopes
67C	Renshaw-Sioux loams, 2 to 9 percent slopes
68E	Sioux-Renshaw loams, 9 to 25 percent slopes
71	Vallers-Parnell complex
77	Vallers loam, saline
80	Marysland loam
81B	Edgeley loam, 2 to 6 percent slopes
82	Sinai silty clay loam, 0 to 2 percent slopes
82B	Sinai silty clay loam, 2 to 6 percent slopes
83F	Kloten-Buse complex, 9 to 35 percent slopes
84	Easby loam
85	Exline silty clay loam
86	Overly-Nahon silt loams
87	Svea-Cavour loams, 0 to 3 percent slopes
88	Manfred and Vallers soils, extremely stony
89	Fordville loam, 0 to 3 percent slopes
90	Dovray silty clay
91	Arveson loam
92B	Barnes-Cavour loams, 3 to 6 percent slopes
98B	Barnes-Svea loams, 0 to 6 percent slopes, extremely stony

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline and neatline

AD HOC BOUNDARY (label) — Swift Airport

- Small airport, airfield, park, oilfield, cemetery, or flood pool — FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNER (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate — 21
- Federal — 173
- State — 28
- County, farm or ranch — 1283

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or Small > 3 acres in size — water, w

PITS

- Gravel pit < 3 acres in size
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — Gas
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water, w
- Intermittent — int, i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 26 27

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

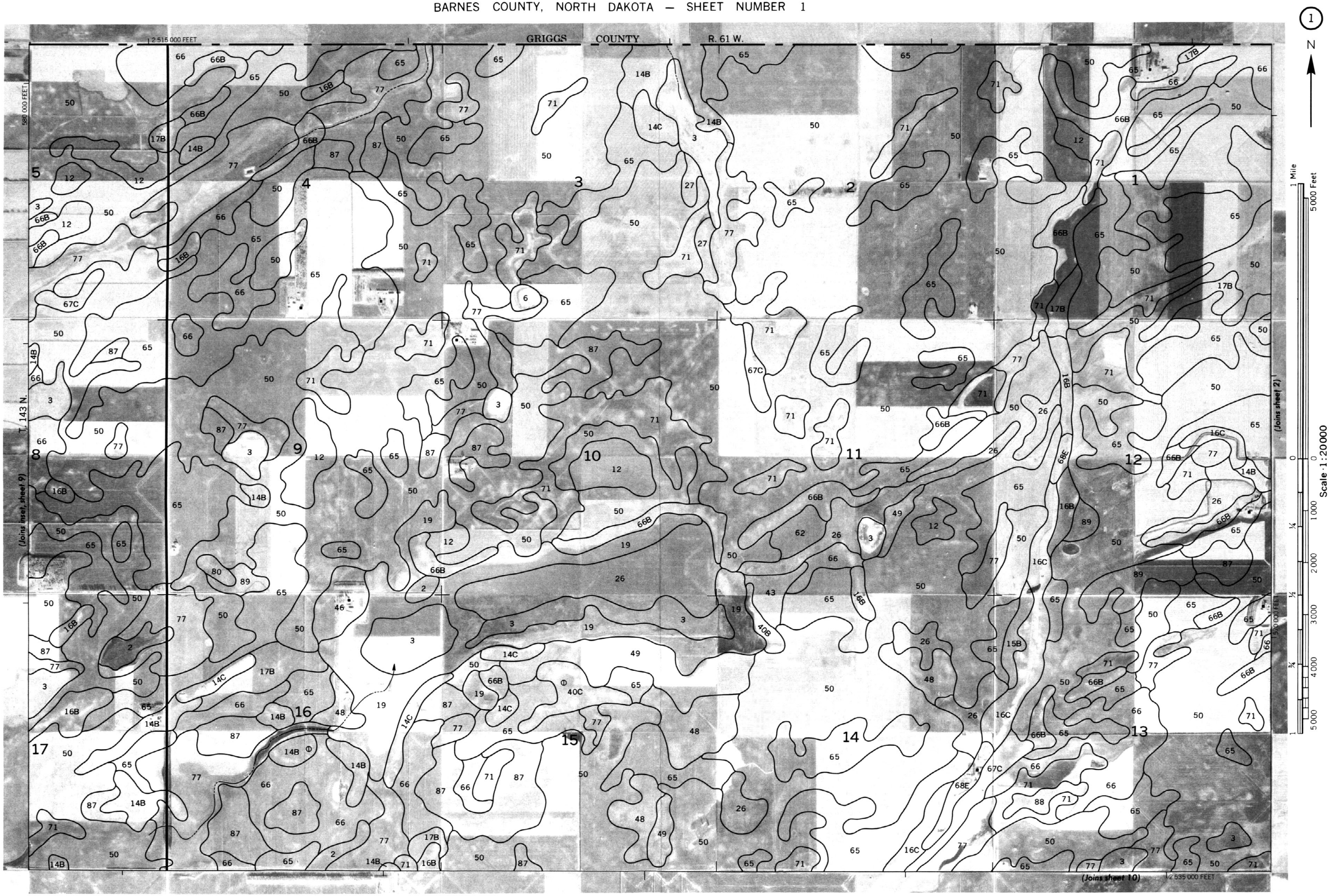
DEPRESSION OR SINK

SOIL SAMPLE (normally not shown)

MISCELLANEOUS

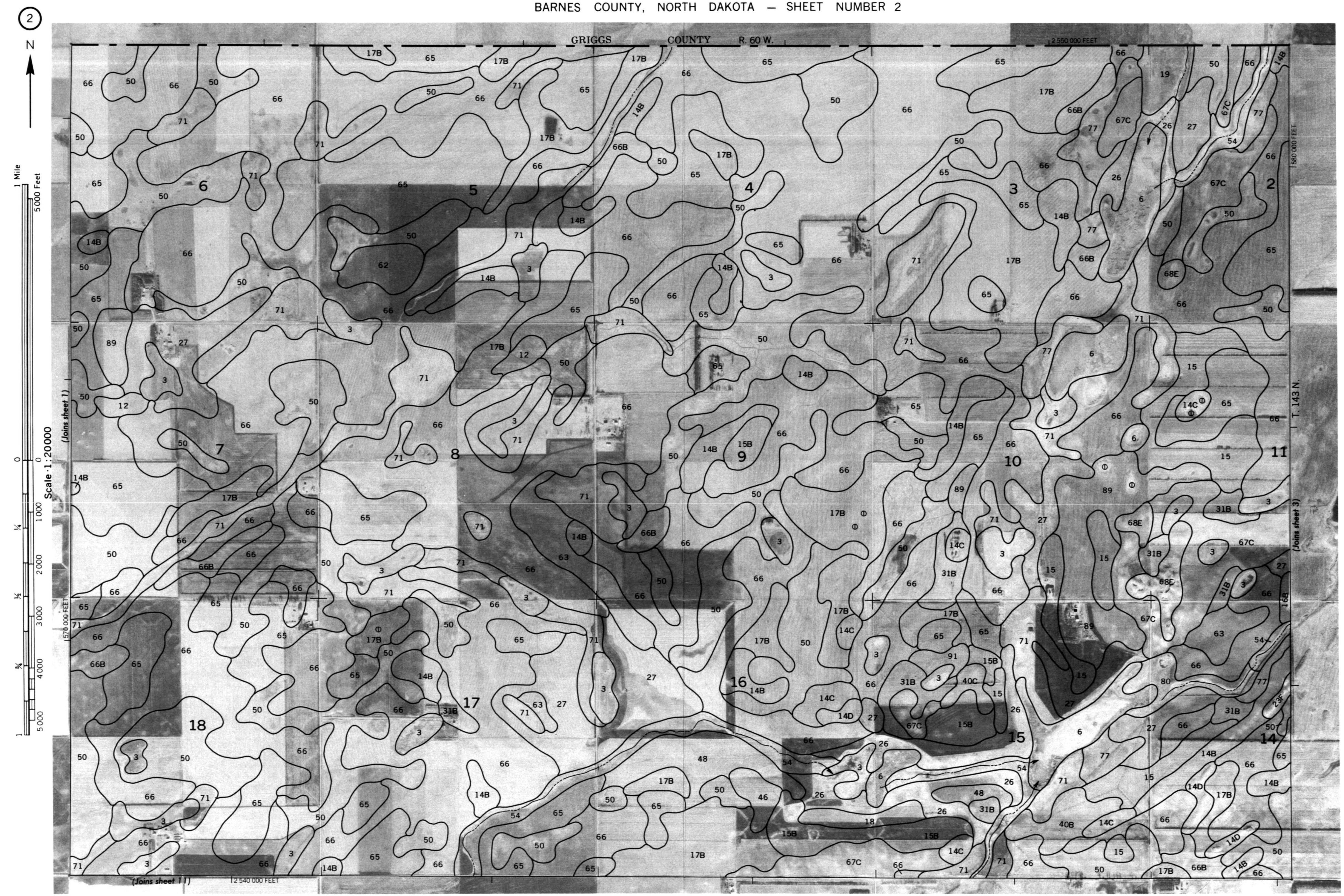
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Potholes ½ to 3 acres in size

BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 1



BARNES COUNTY, NORTH DAKOTA NO. 1

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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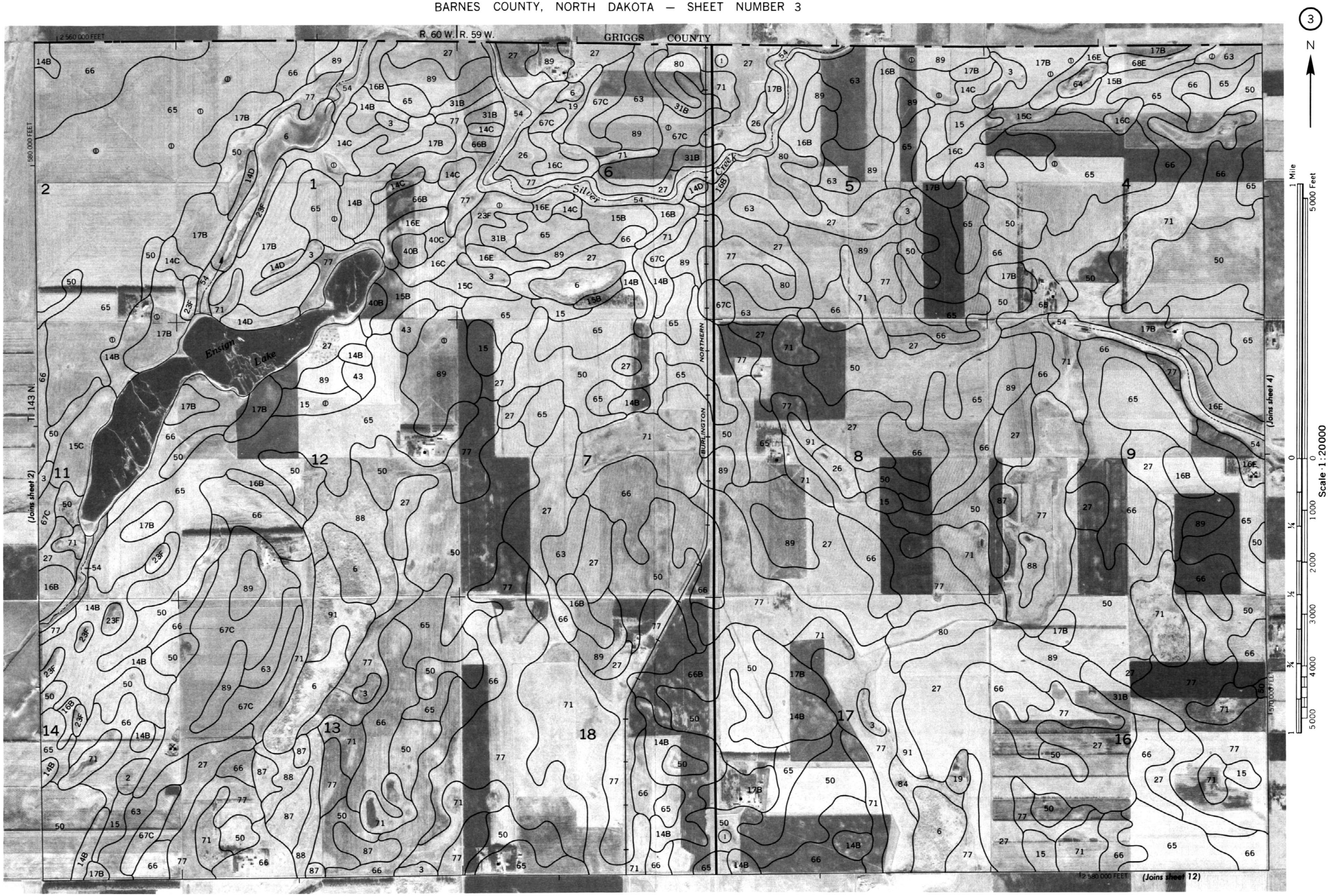
BARNES COUNTY, NORTH DAKOTA NO. 2



BARNES COUNTY, NORTH DAKOTA NO. 3

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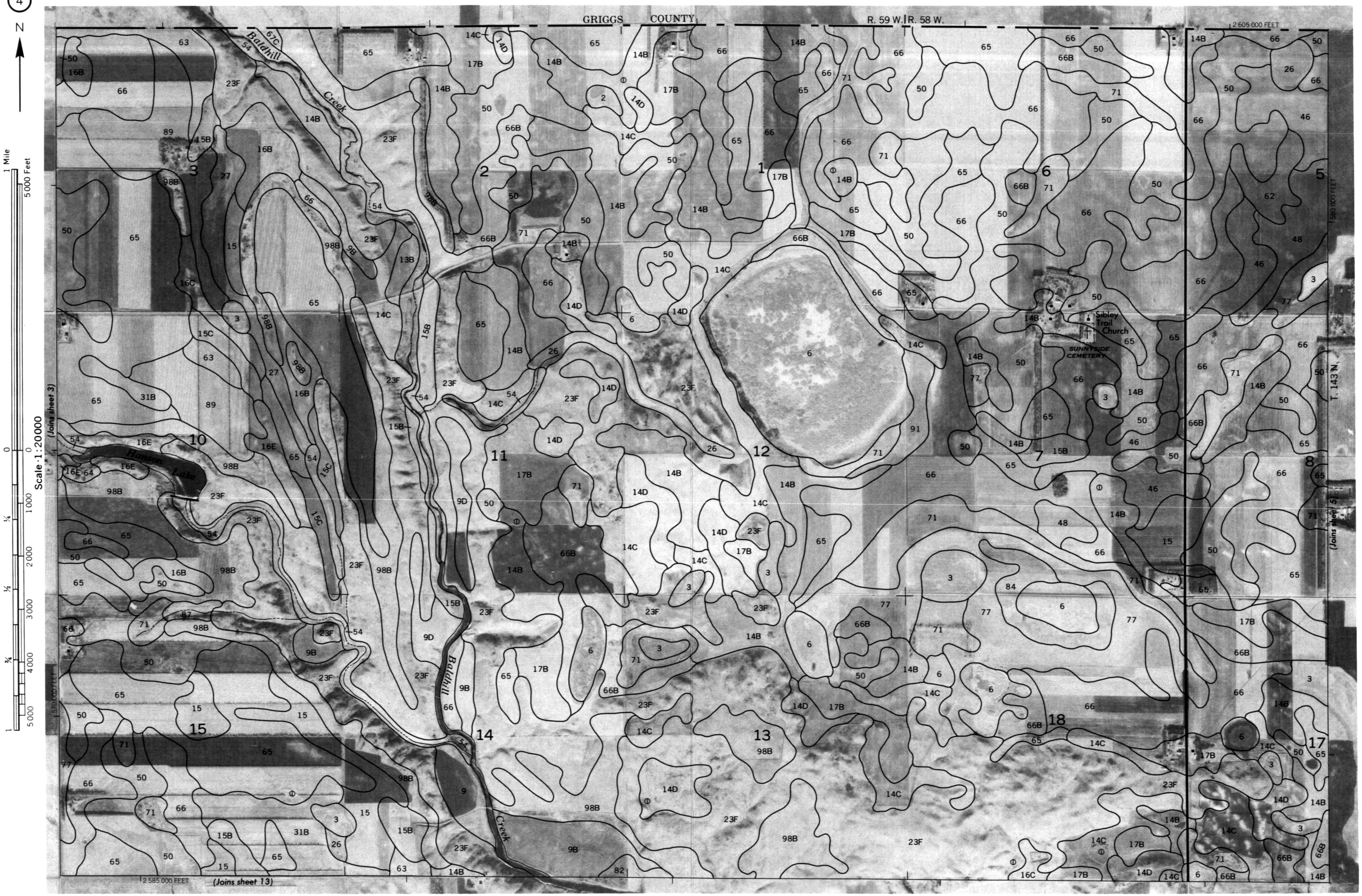
BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 4



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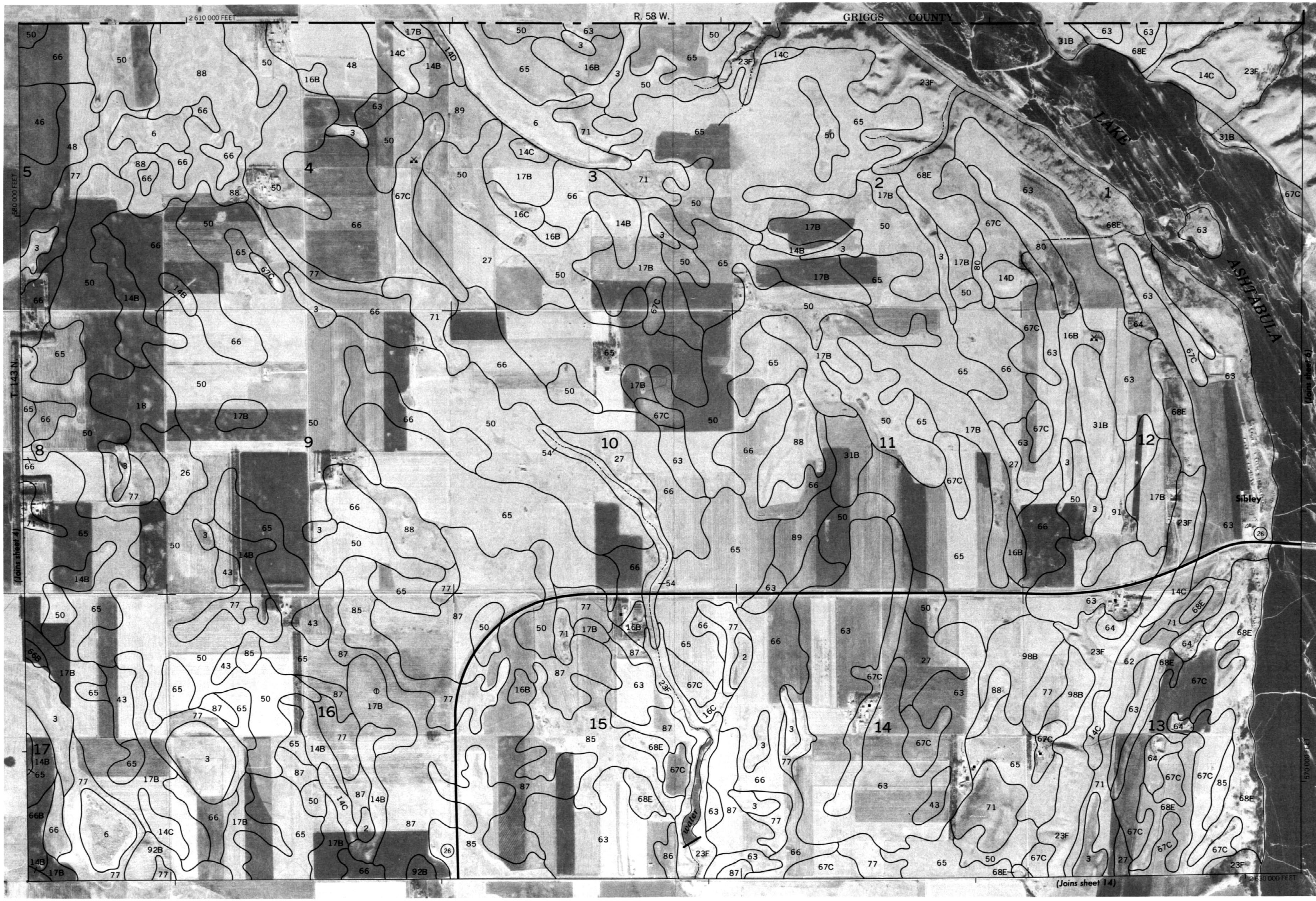
BARNES COUNTY, NORTH DAKOTA NO. 4

5



N

1 Mile
5000 Feet
Scale 1:20000

BARNES COUNTY, NORTH DAKOTA NO. 5

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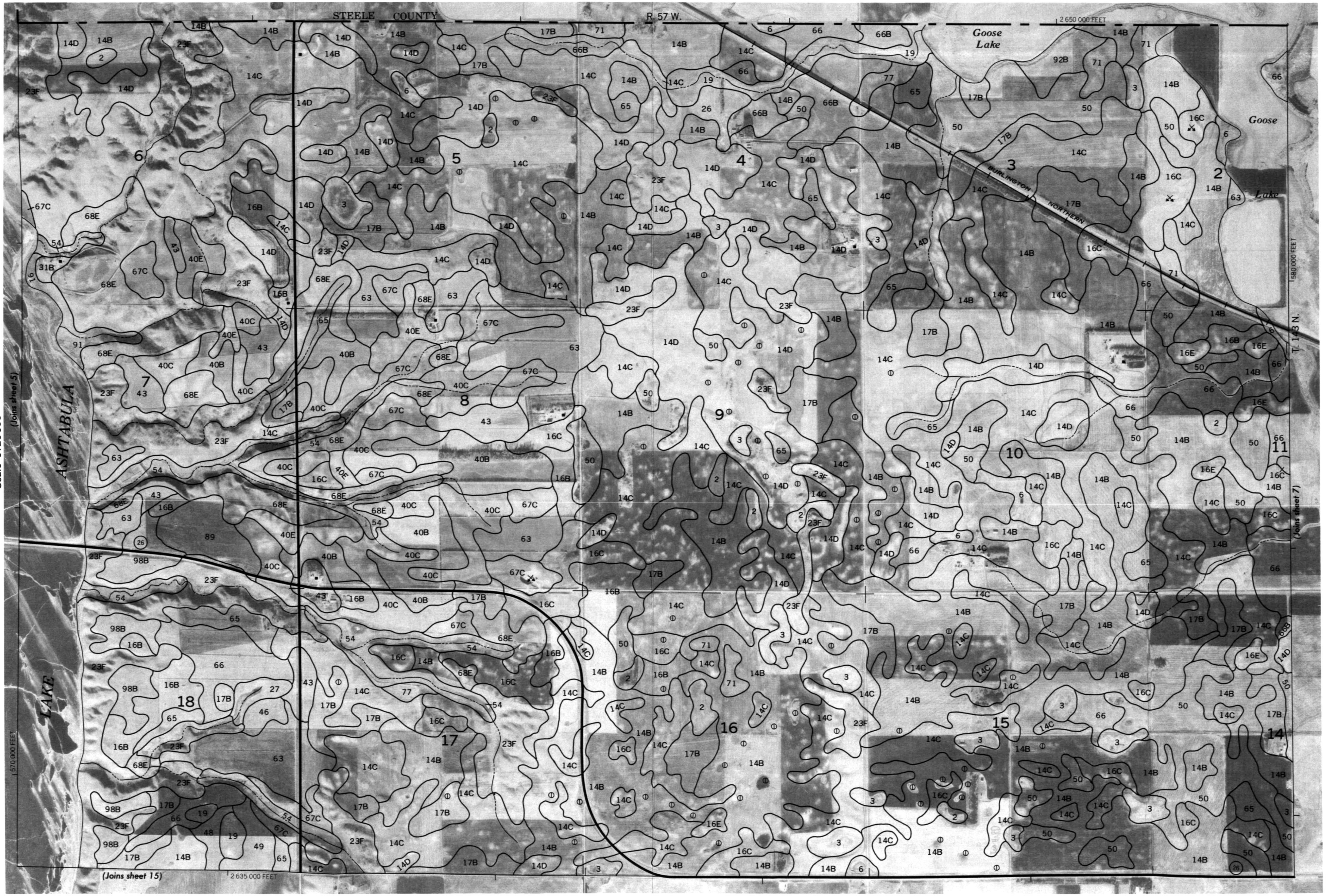
BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 6

N

1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000 Feet



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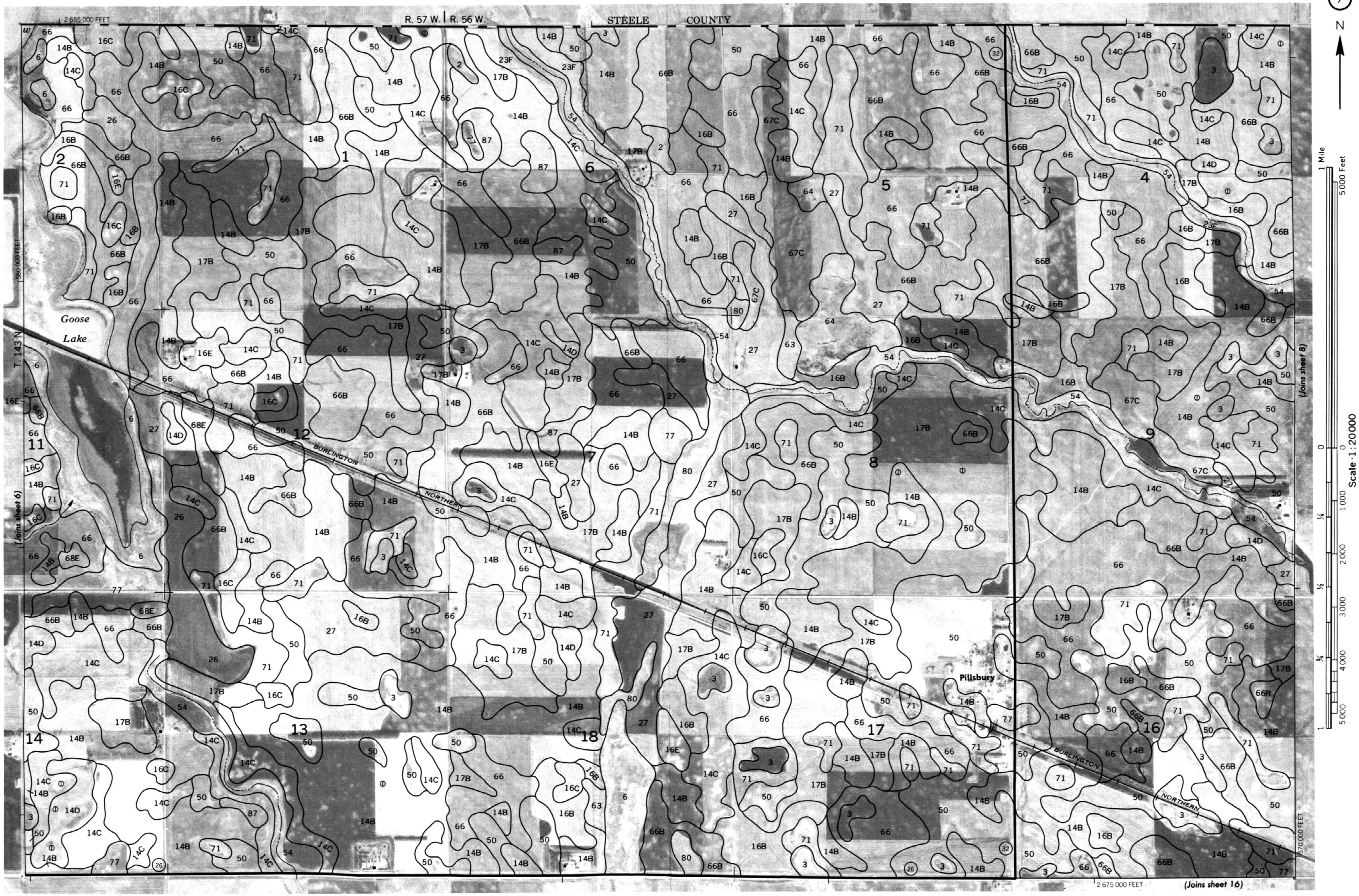
BARNES COUNTY, NORTH DAKOTA NO. 6

BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 7



BARNES COUNTY, NORTH DAKOTA NO. 7

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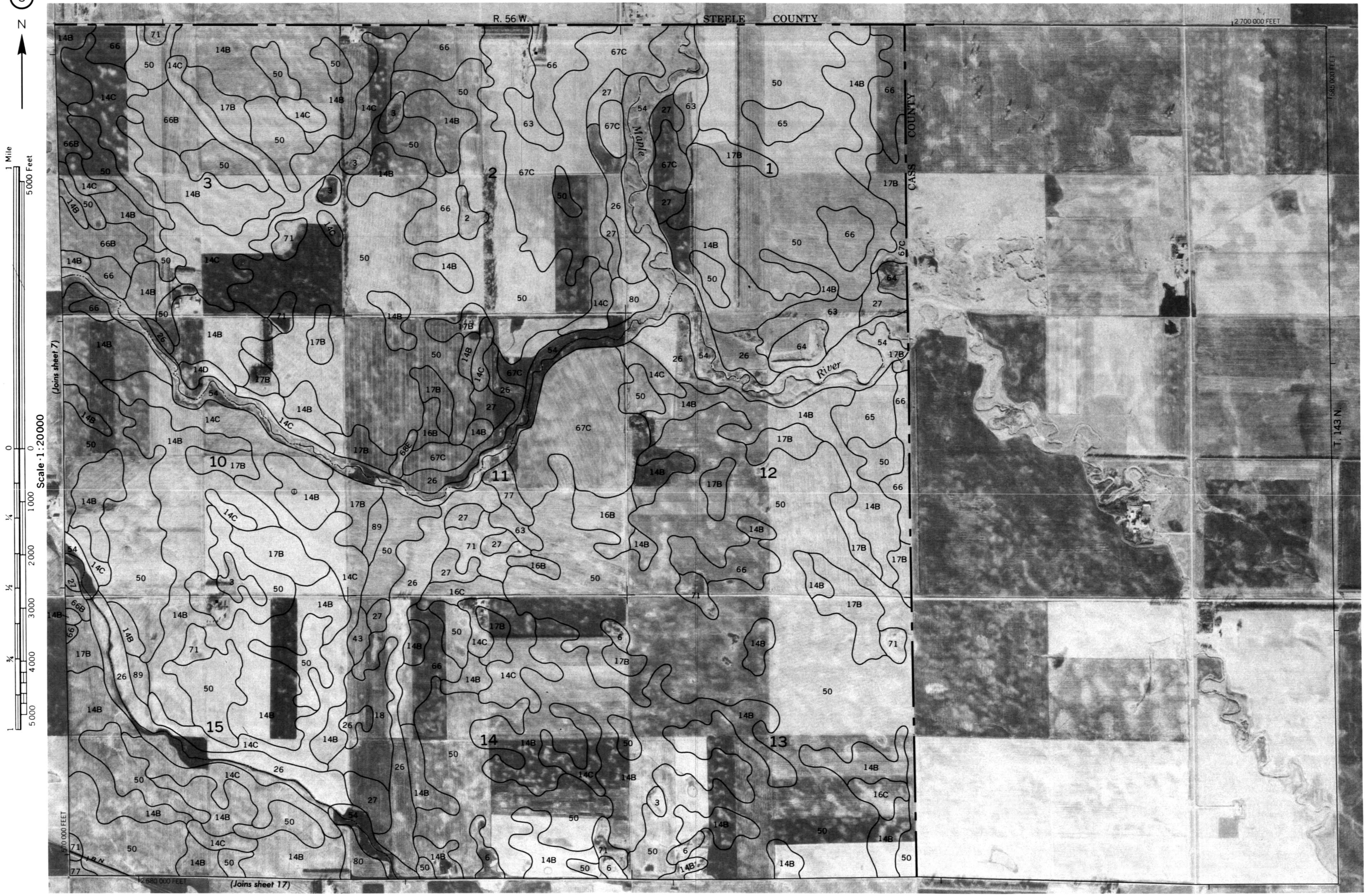
BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 8



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BARNES COUNTY, NORTH DAKOTA NO. 8

BARNES COUNTY, NORTH DAKOTA NO. 9

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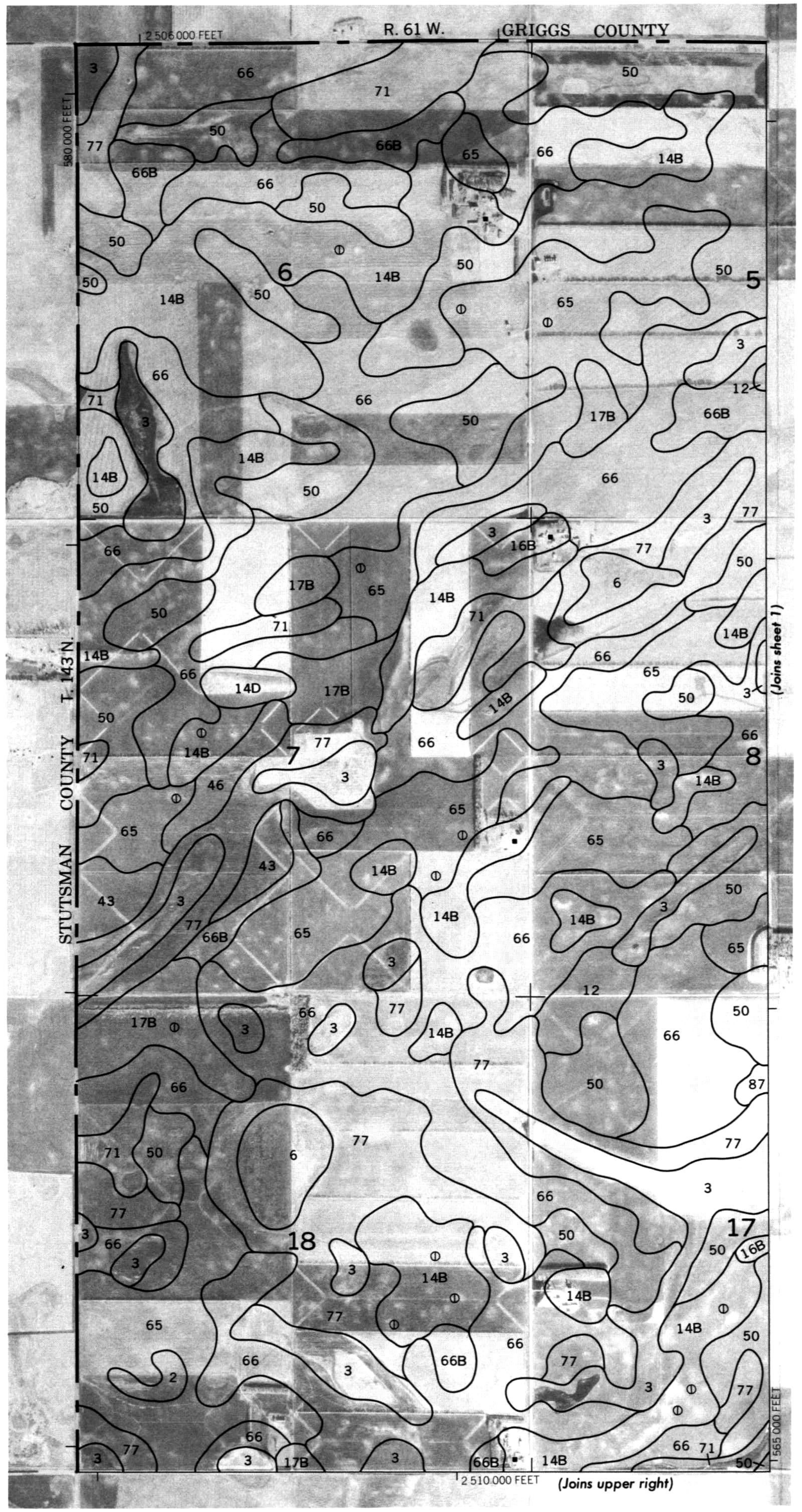
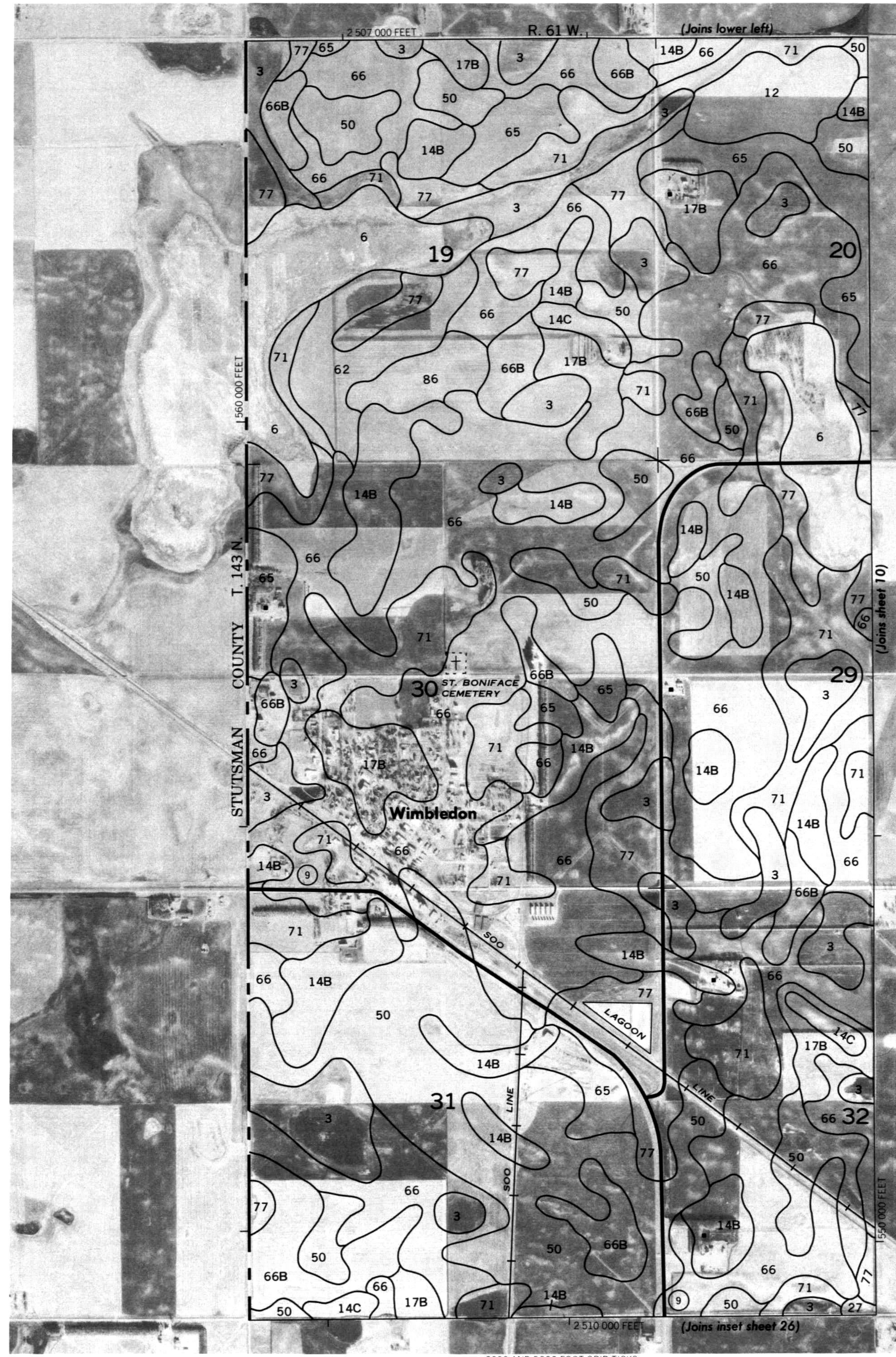
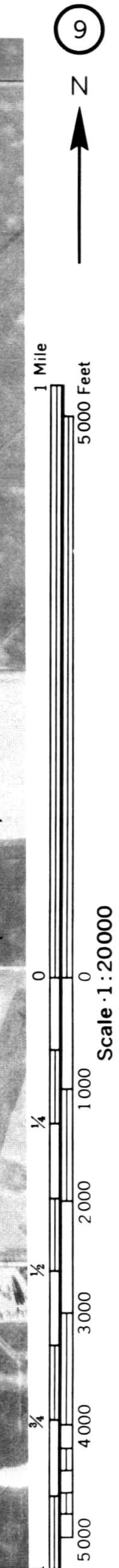
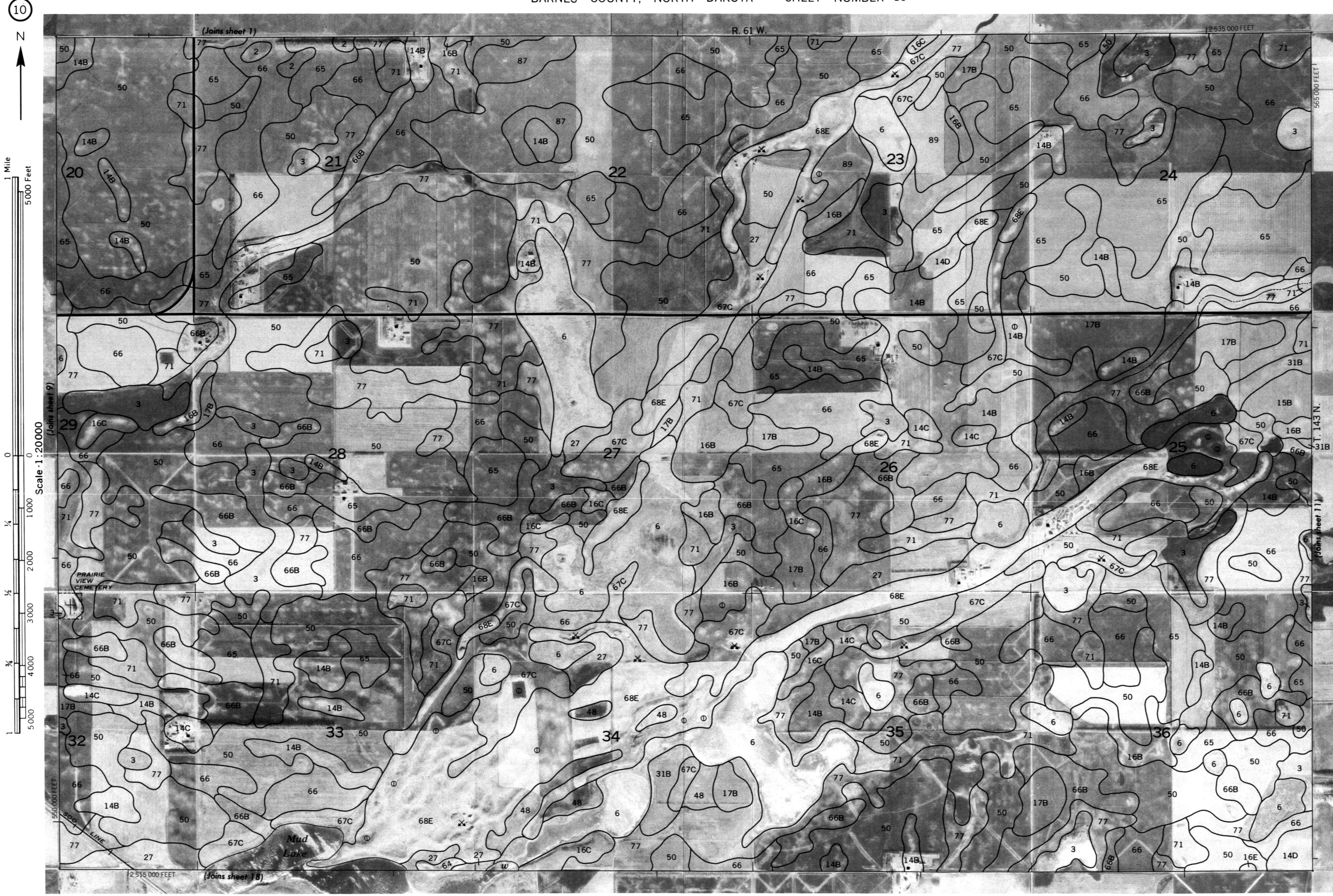


4000 AND 5000-FOOT GRID TICKS



3000 AND 5000-FOOT GRID TICKS





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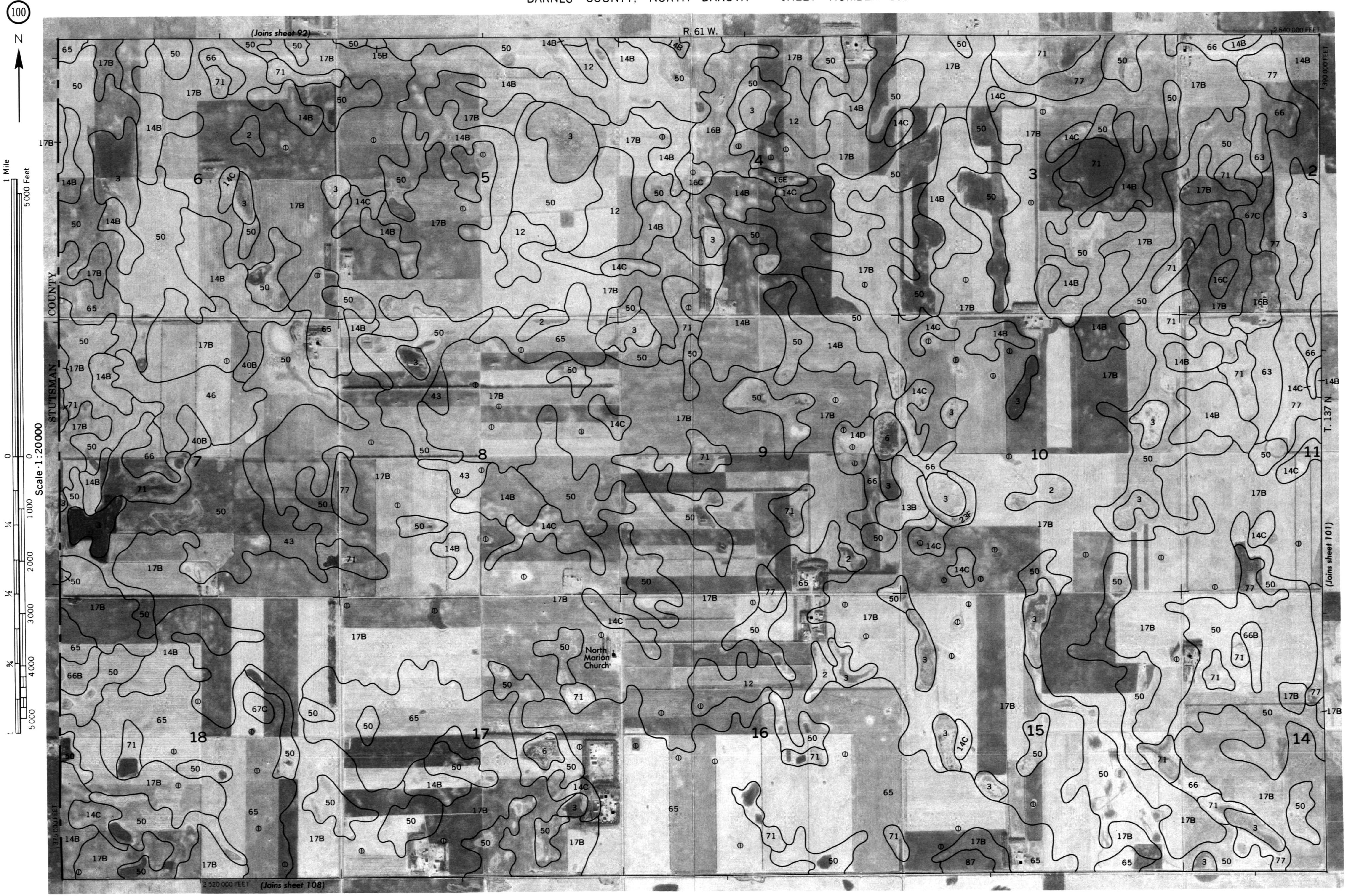
BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 100



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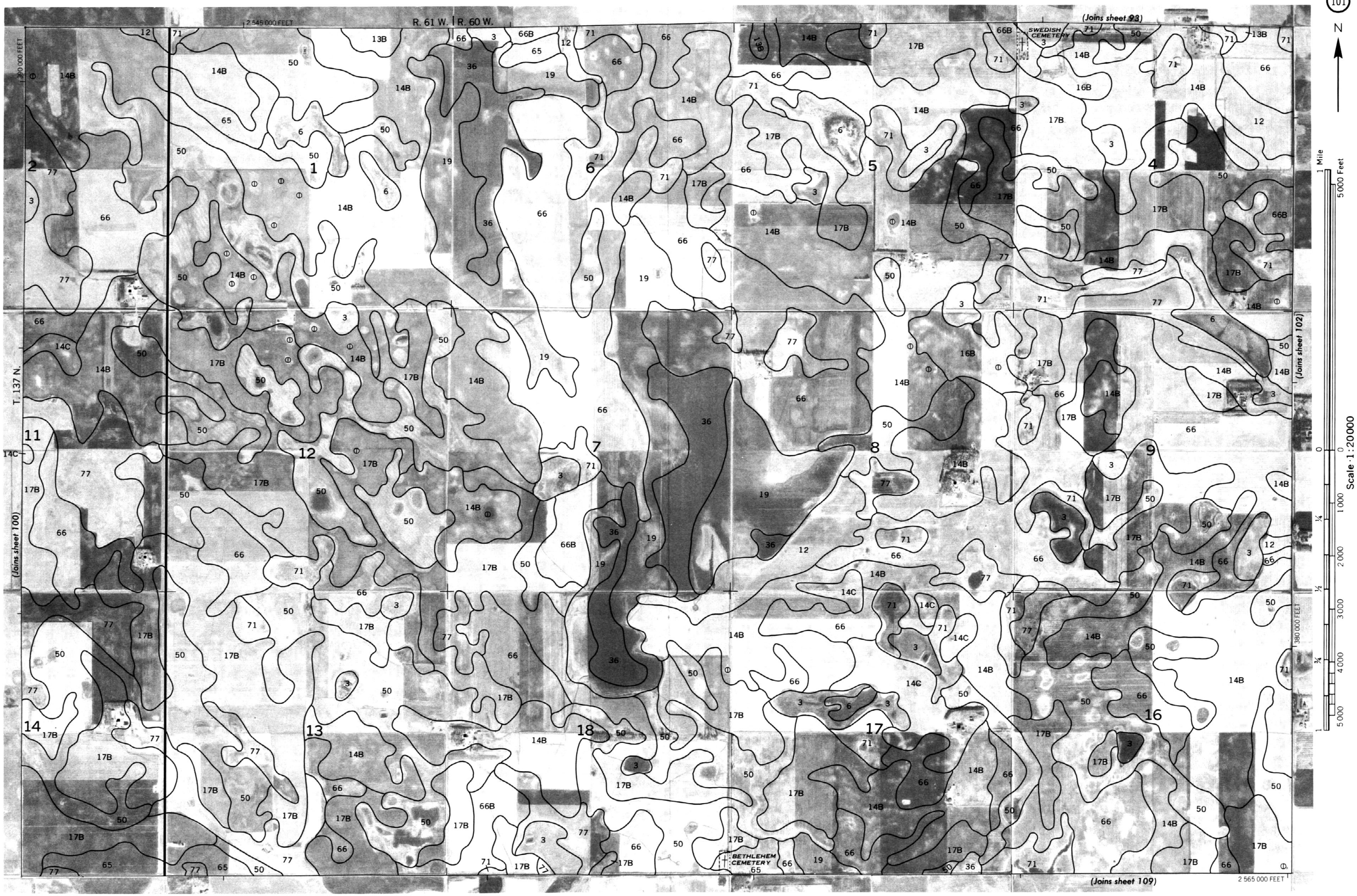
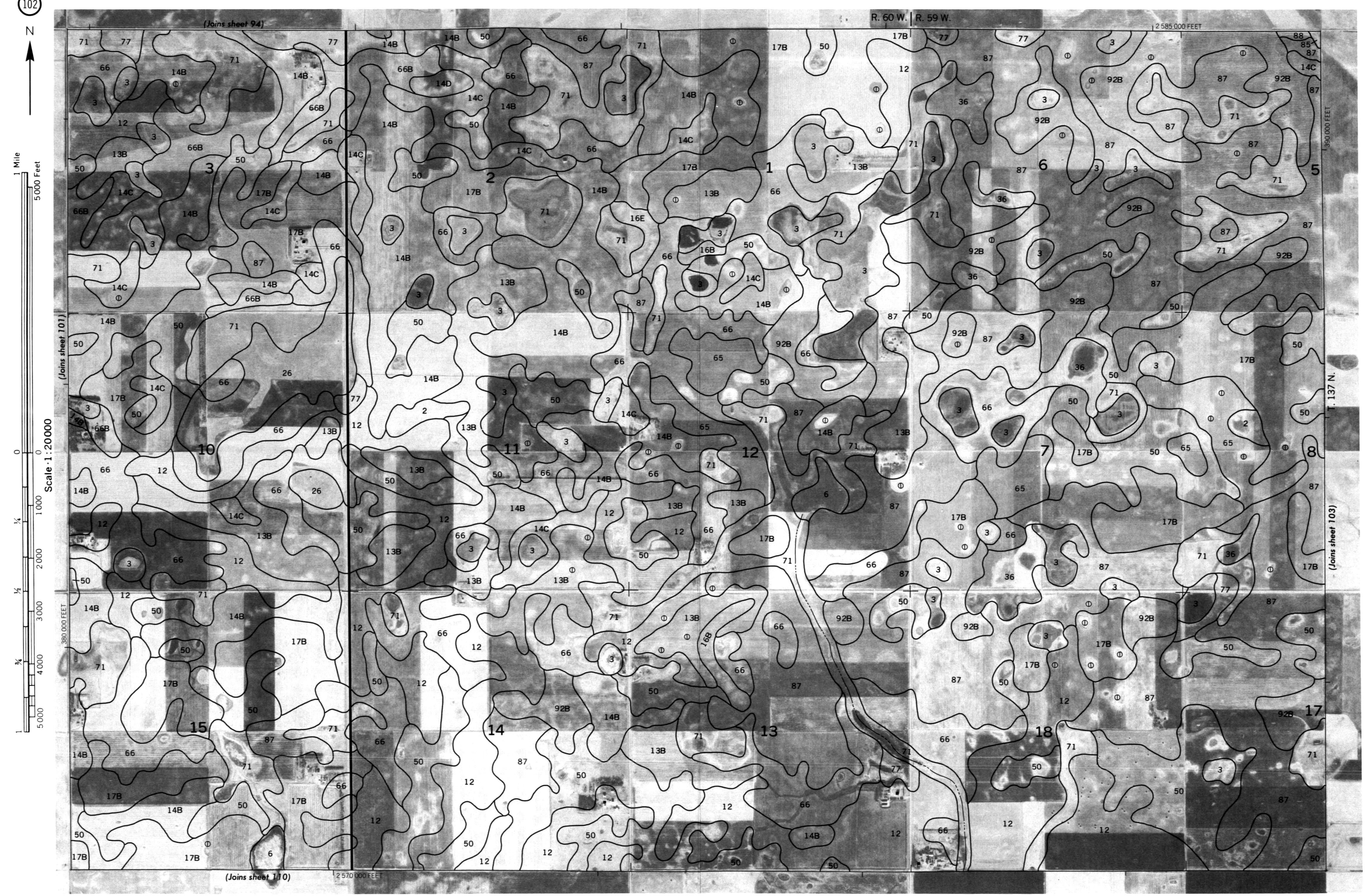
BARNES COUNTY, NORTH DAKOTA NO. 100



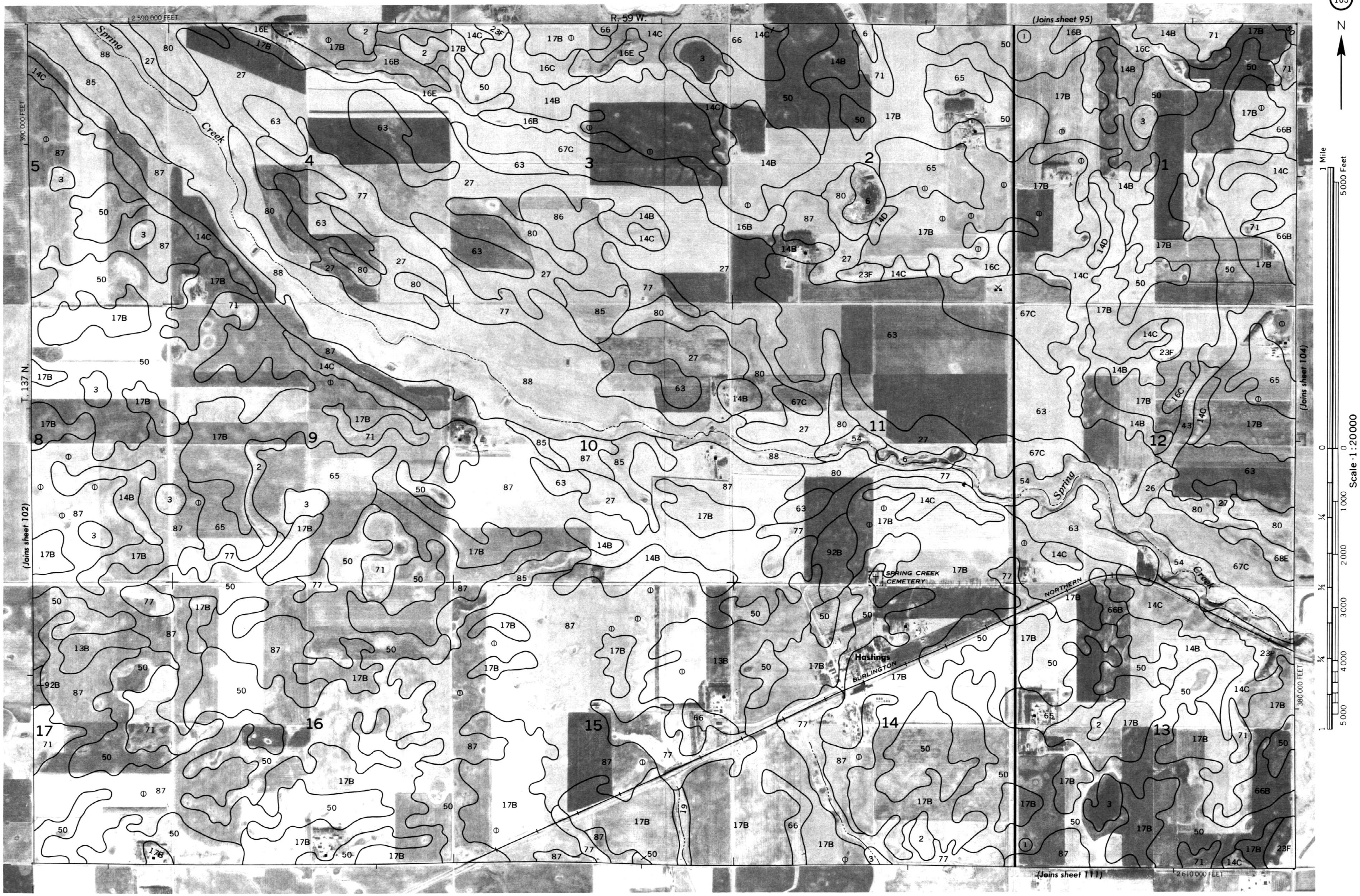
BARNES COUNTY, NORTH DAKOTA NO. 101

This map is compiled on 1979 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

103



BARNES COUNTY, NORTH DAKOTA NO. 103

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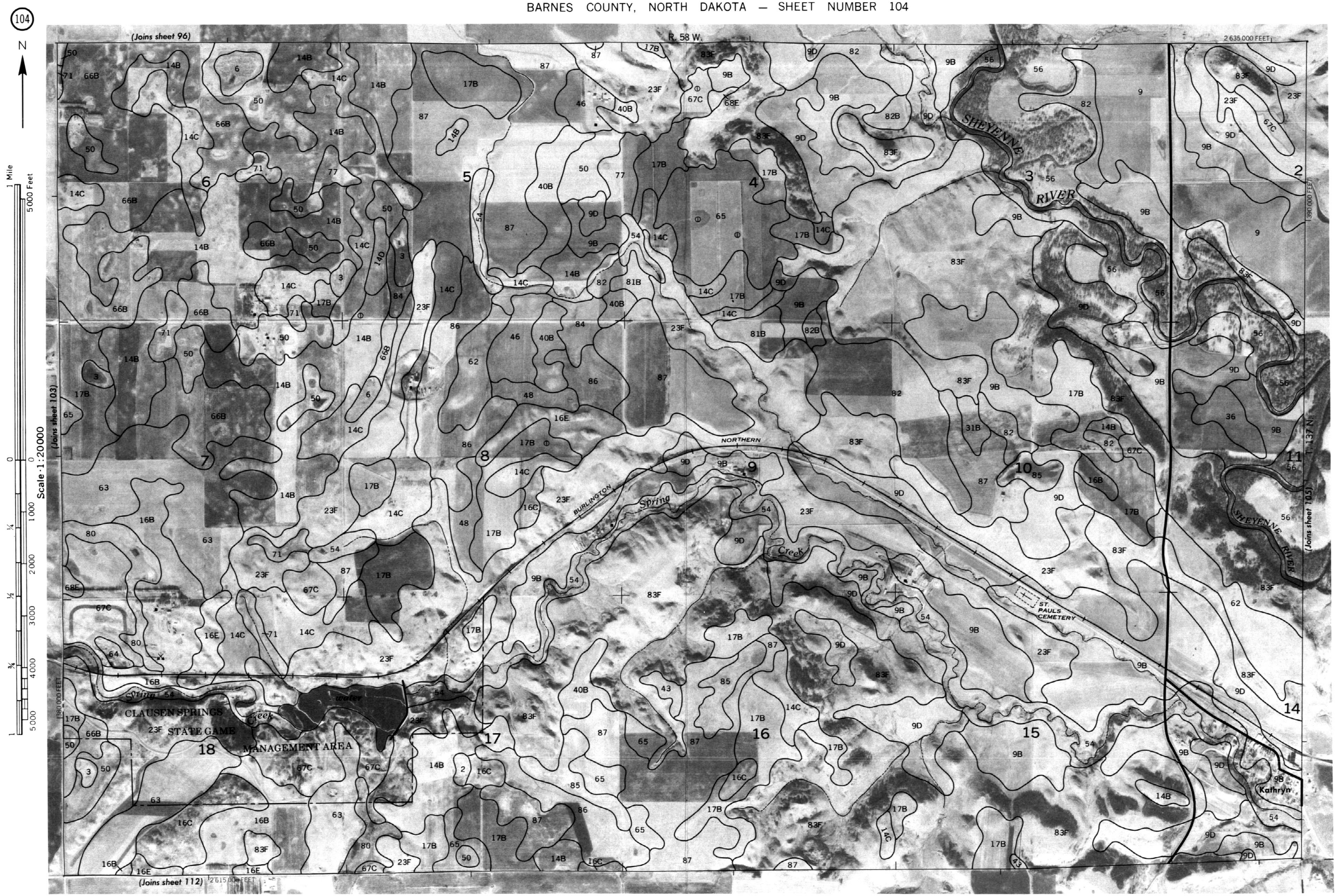

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BARNES COUNTY, NORTH DAKOTA NO. 104

BARNES COUNTY, NORTH DAKOTA NO. 105

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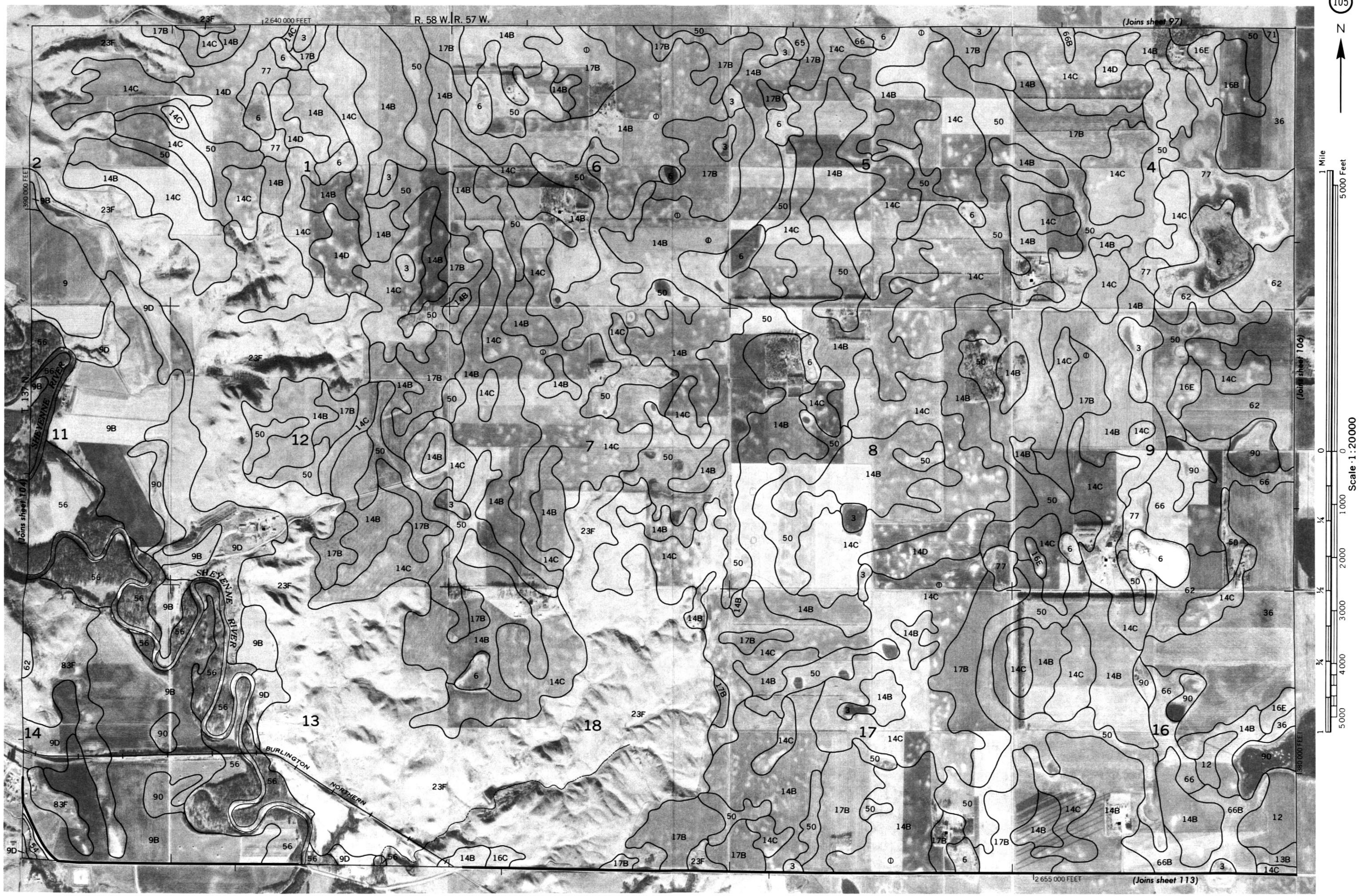


BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 106

N

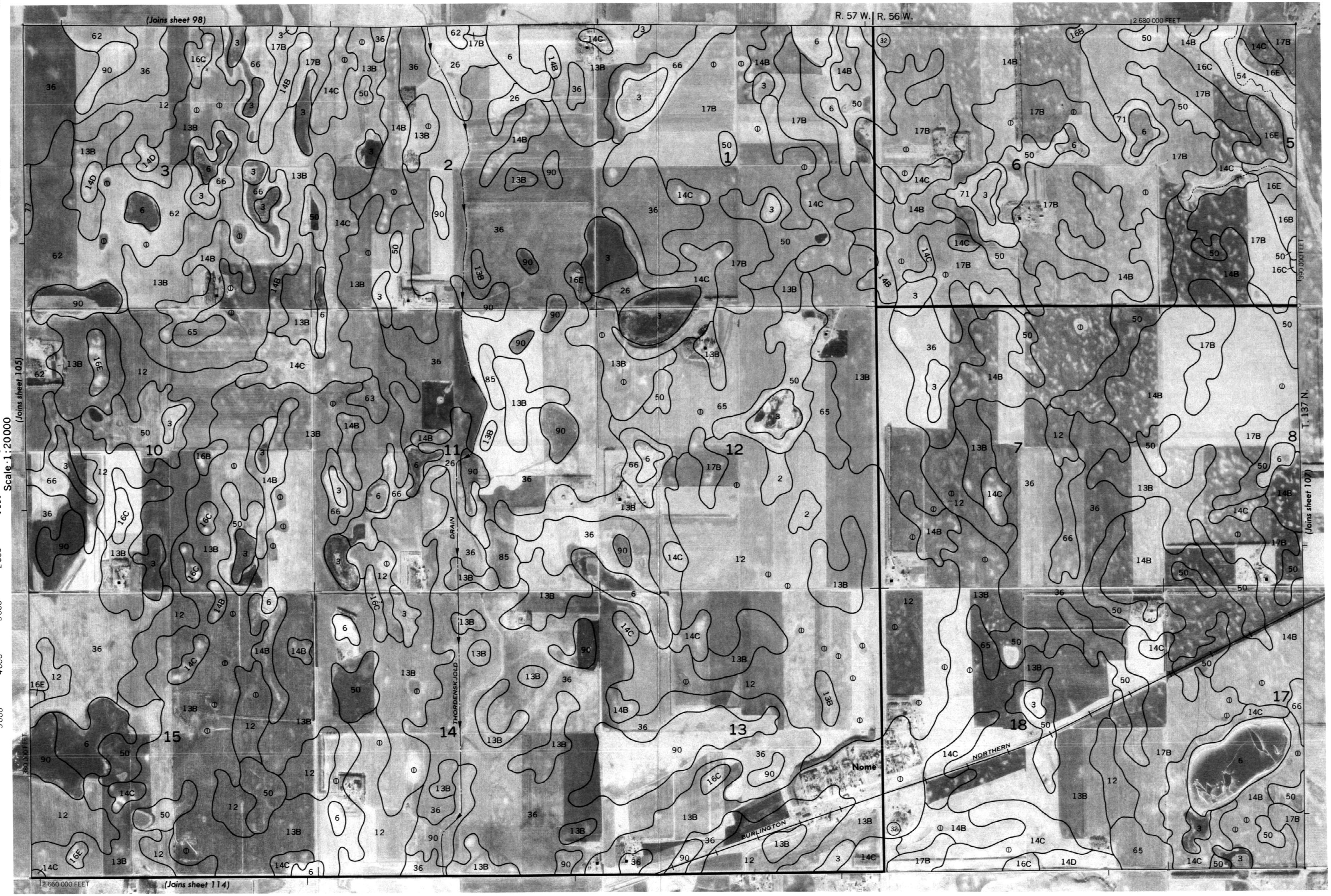
1 Mile

5000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000



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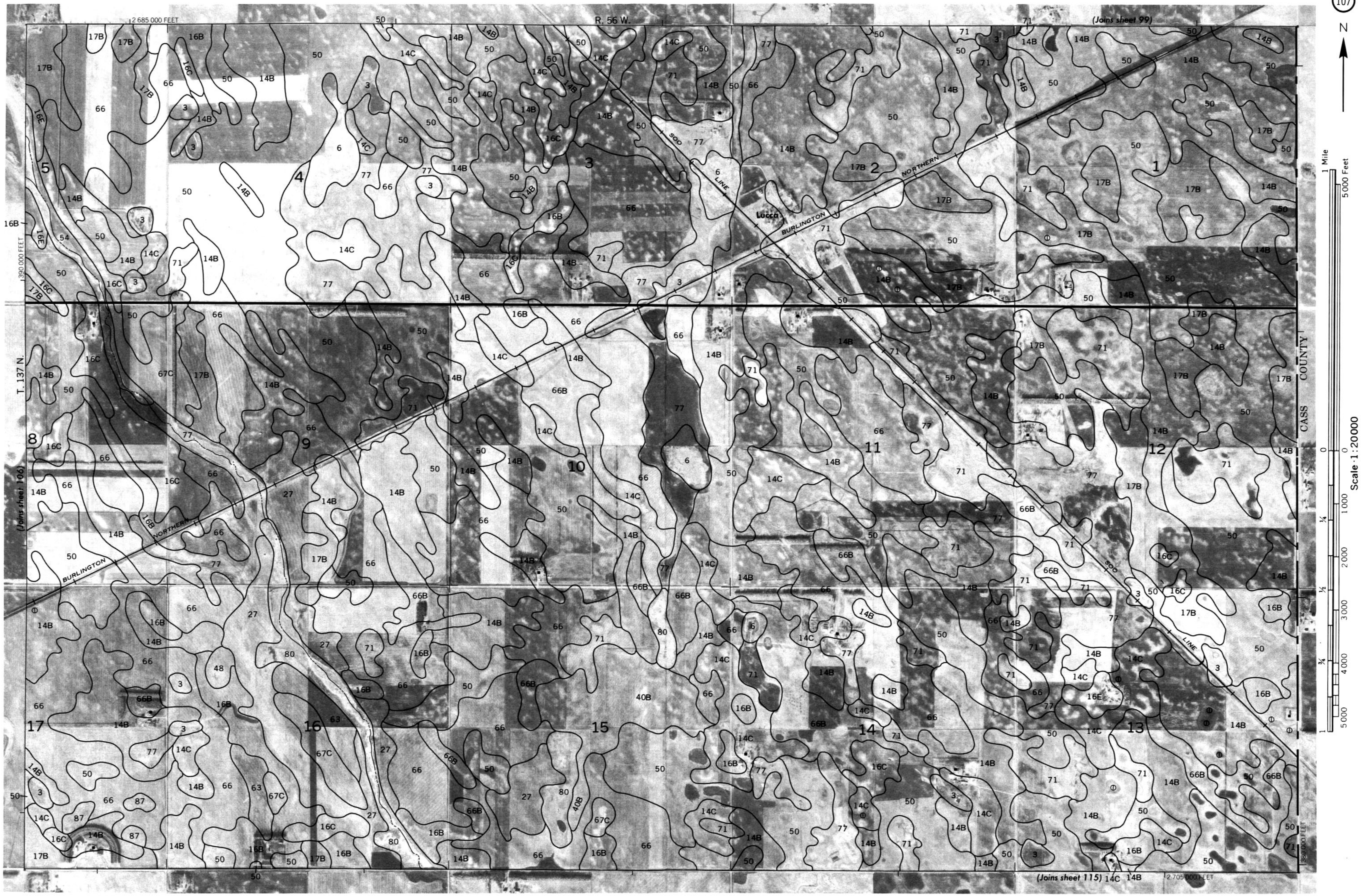
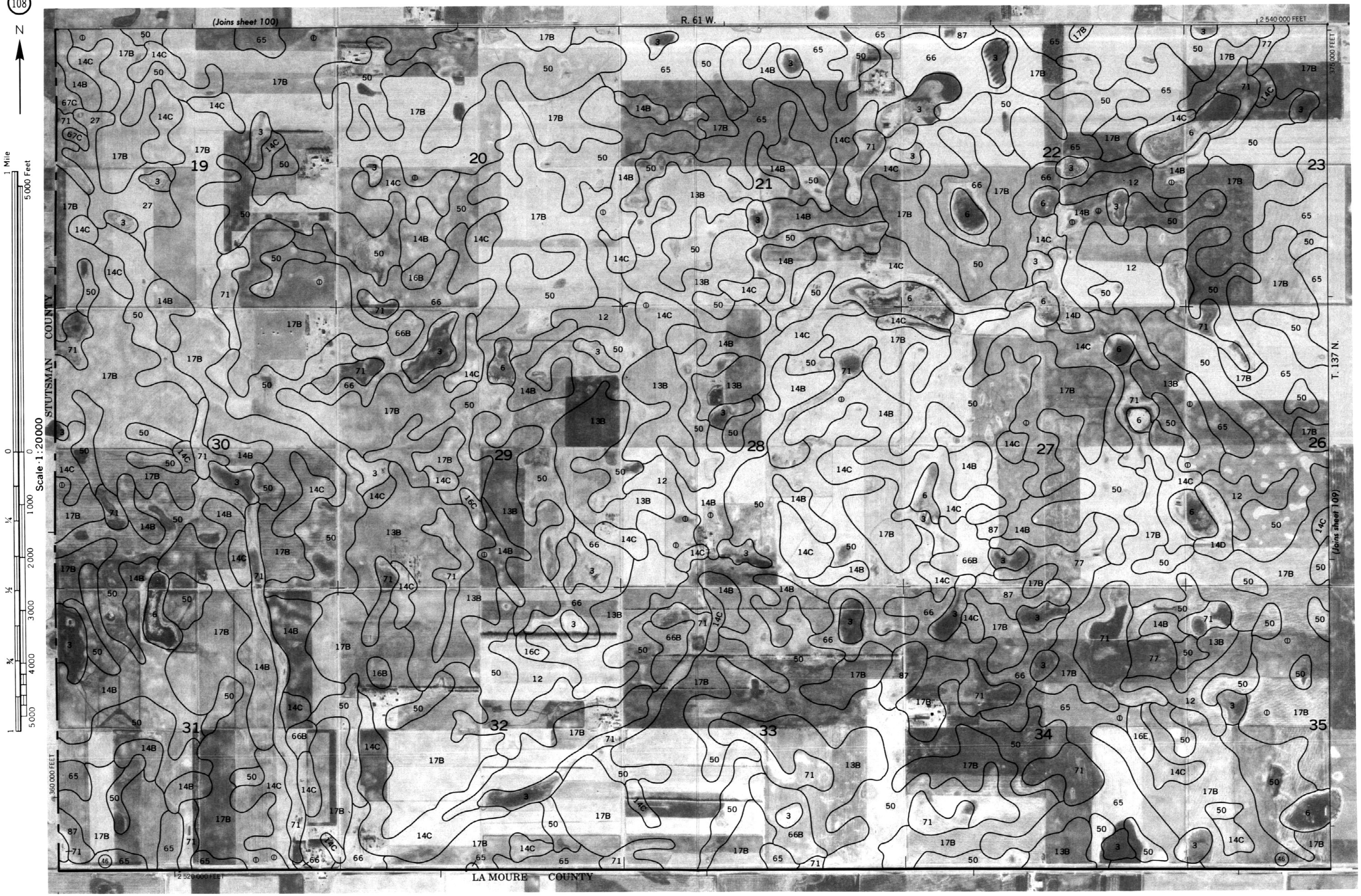
BARNES COUNTY, NORTH DAKOTA NO. 106



BARNES COUNTY, NORTH DAKOTA NO. 107

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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BARNES COUNTY, NORTH DAKOTA NO. 109

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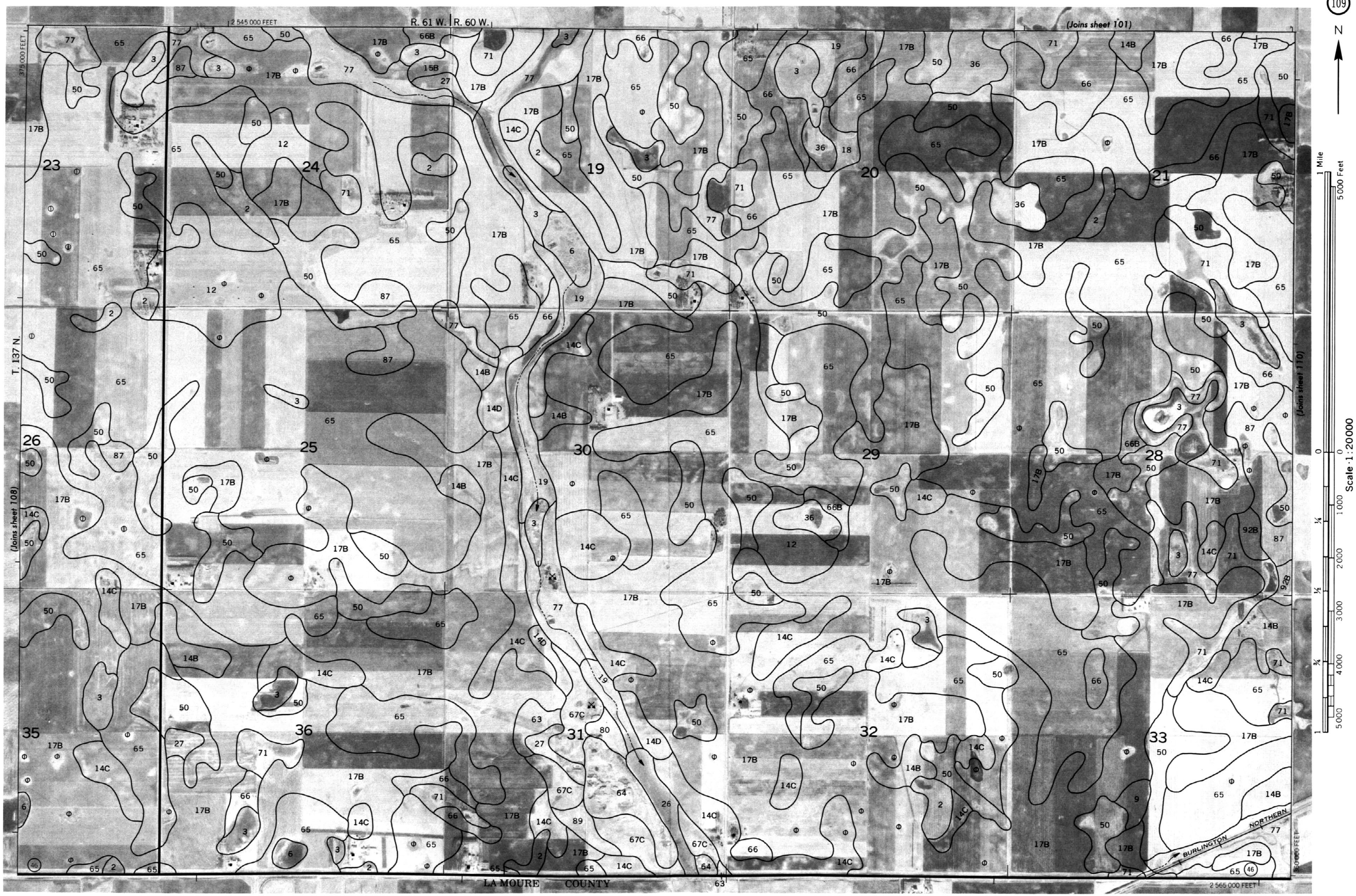

BARNES COUNTY, NORTH DAKOTA NO. 11

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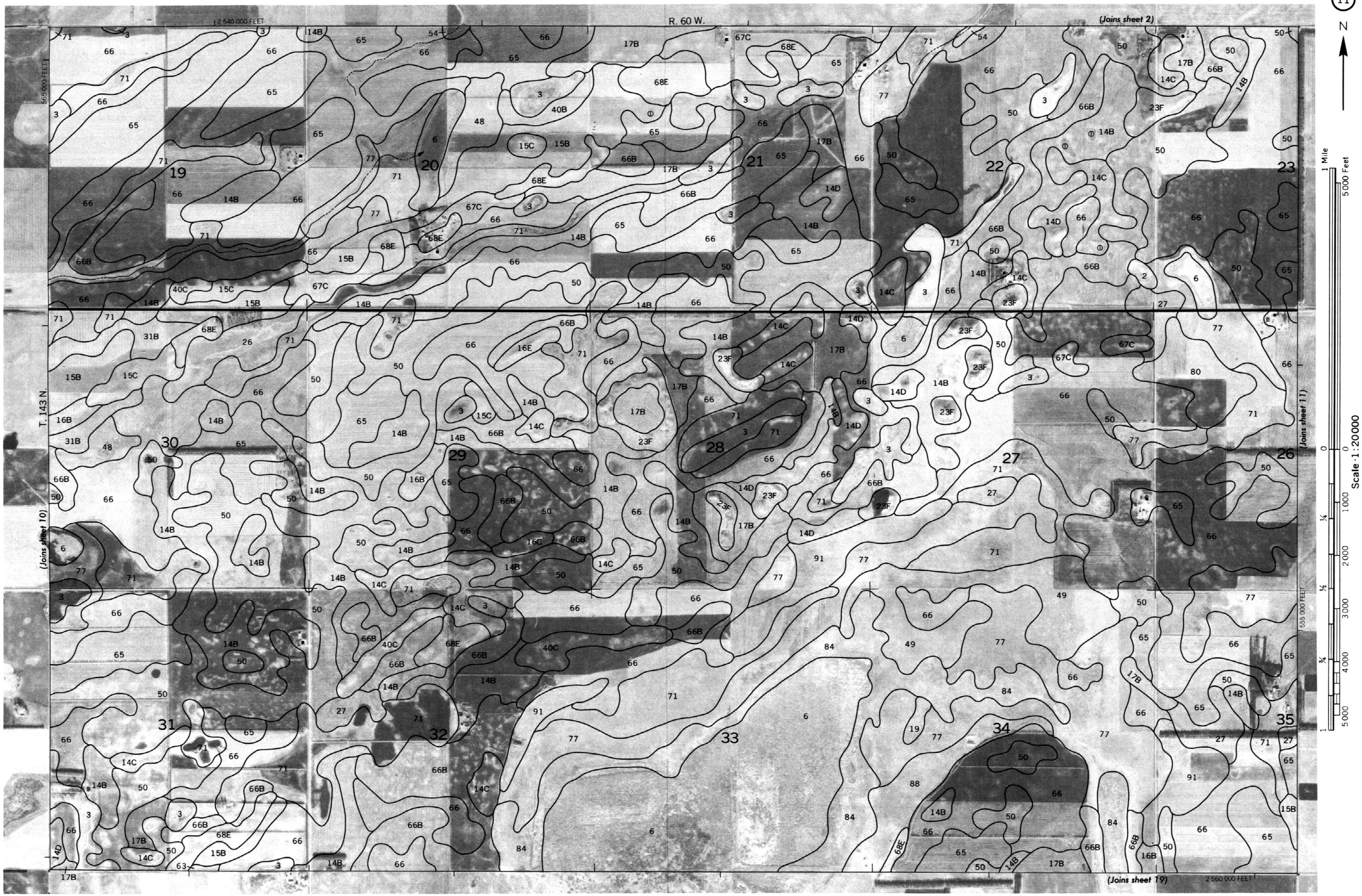

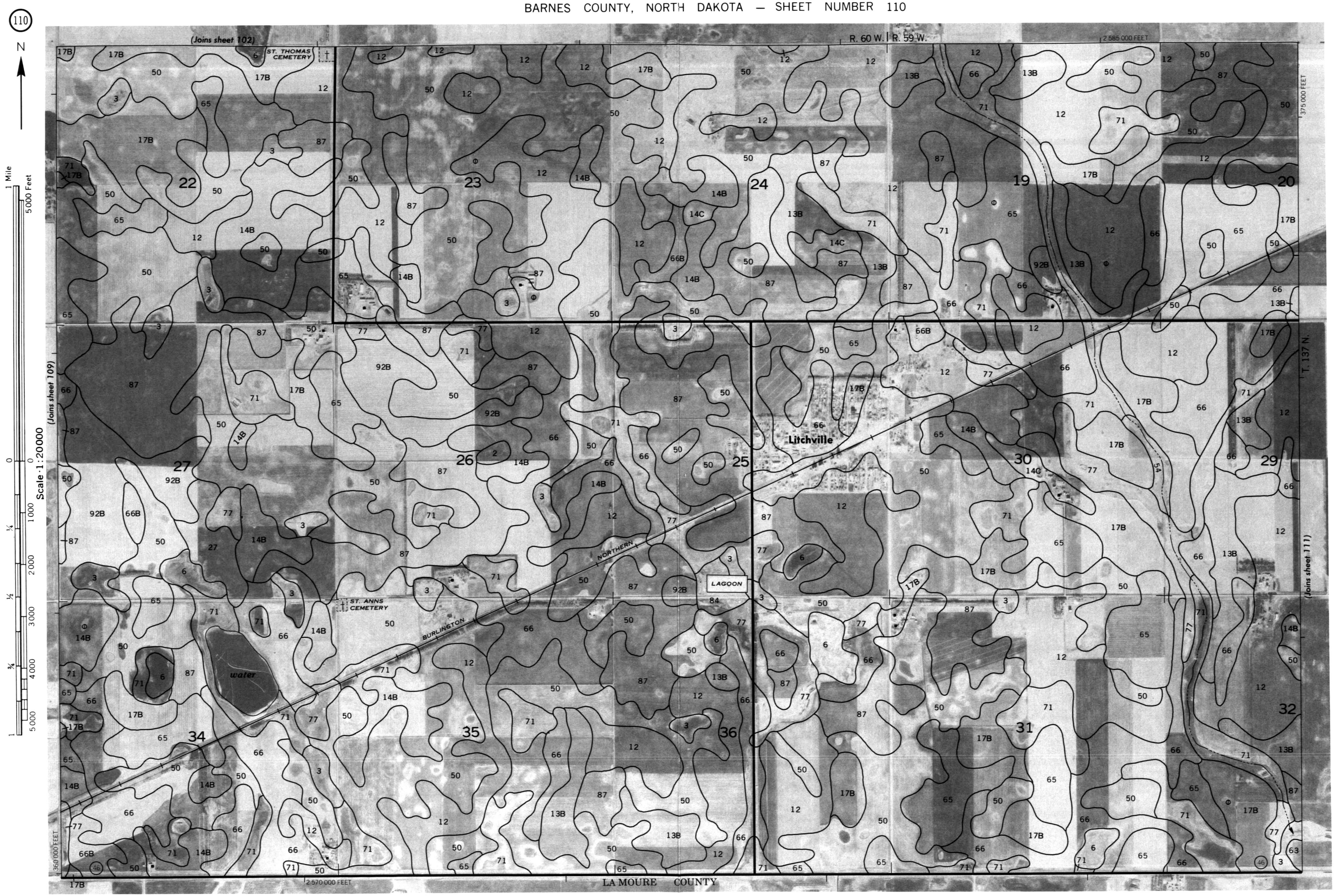

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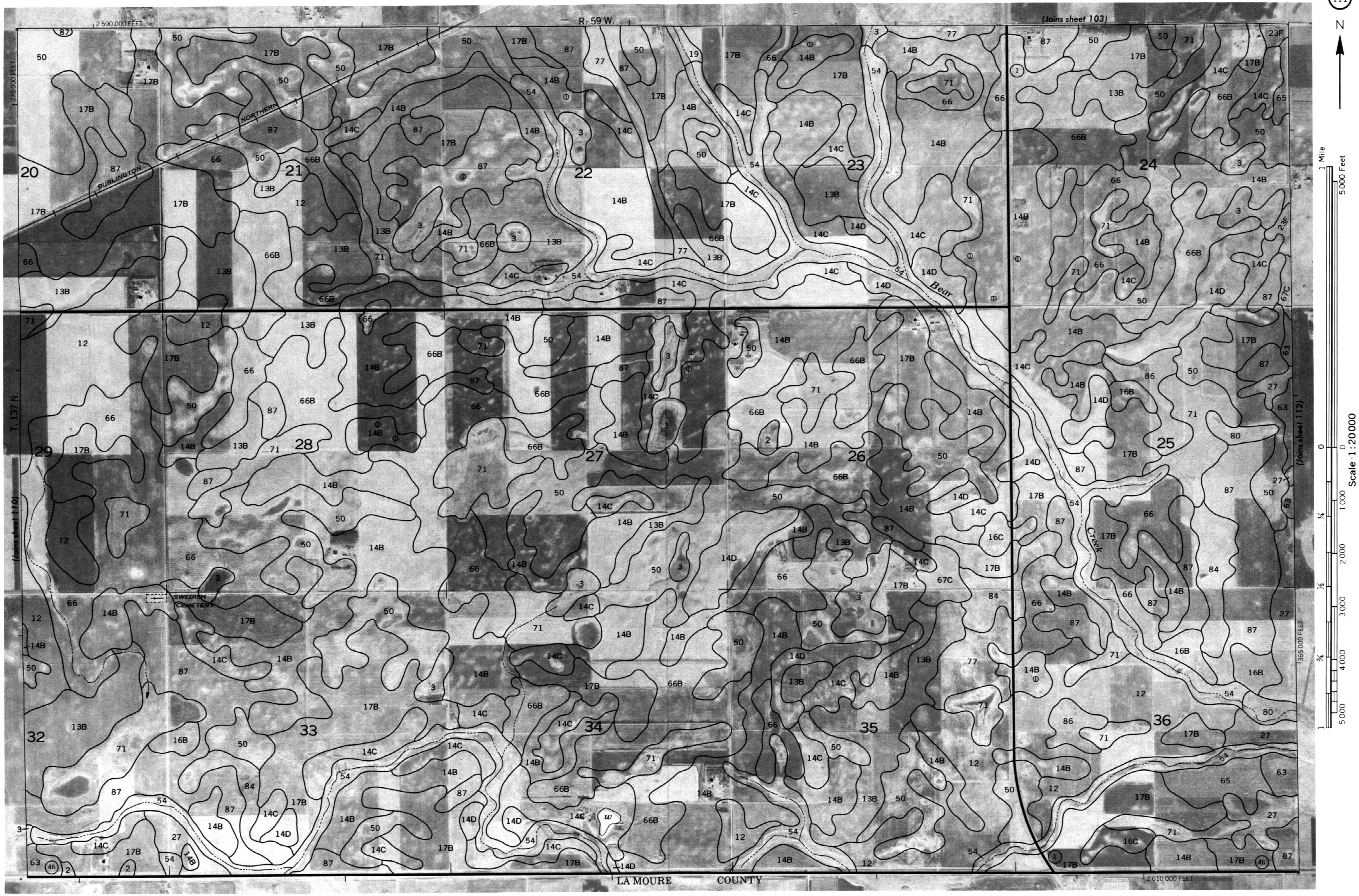

BARNES COUNTY, NORTH DAKOTA NO. 111

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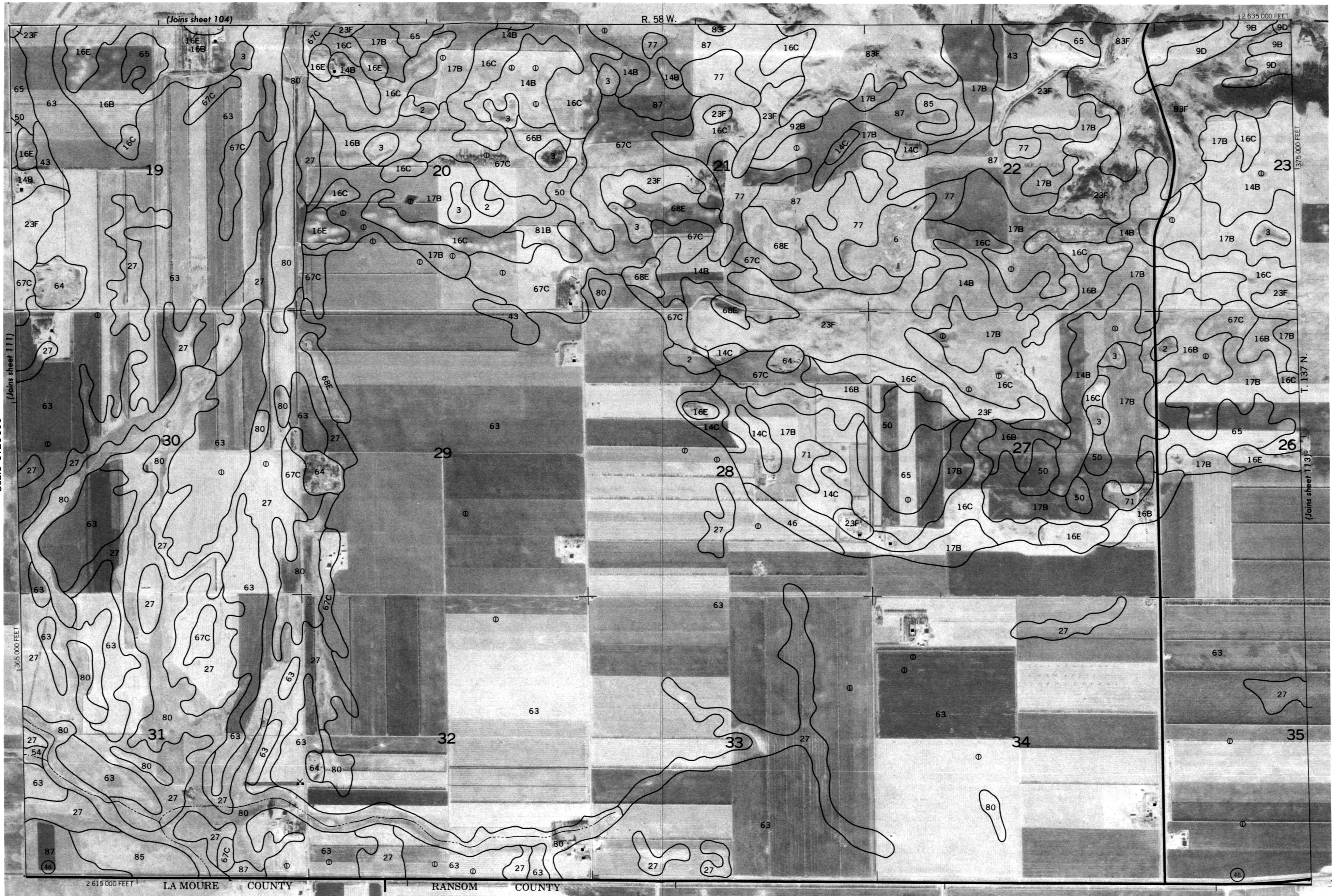
BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 112

N

1 Mile

5000 Feet

Scale 1:20000



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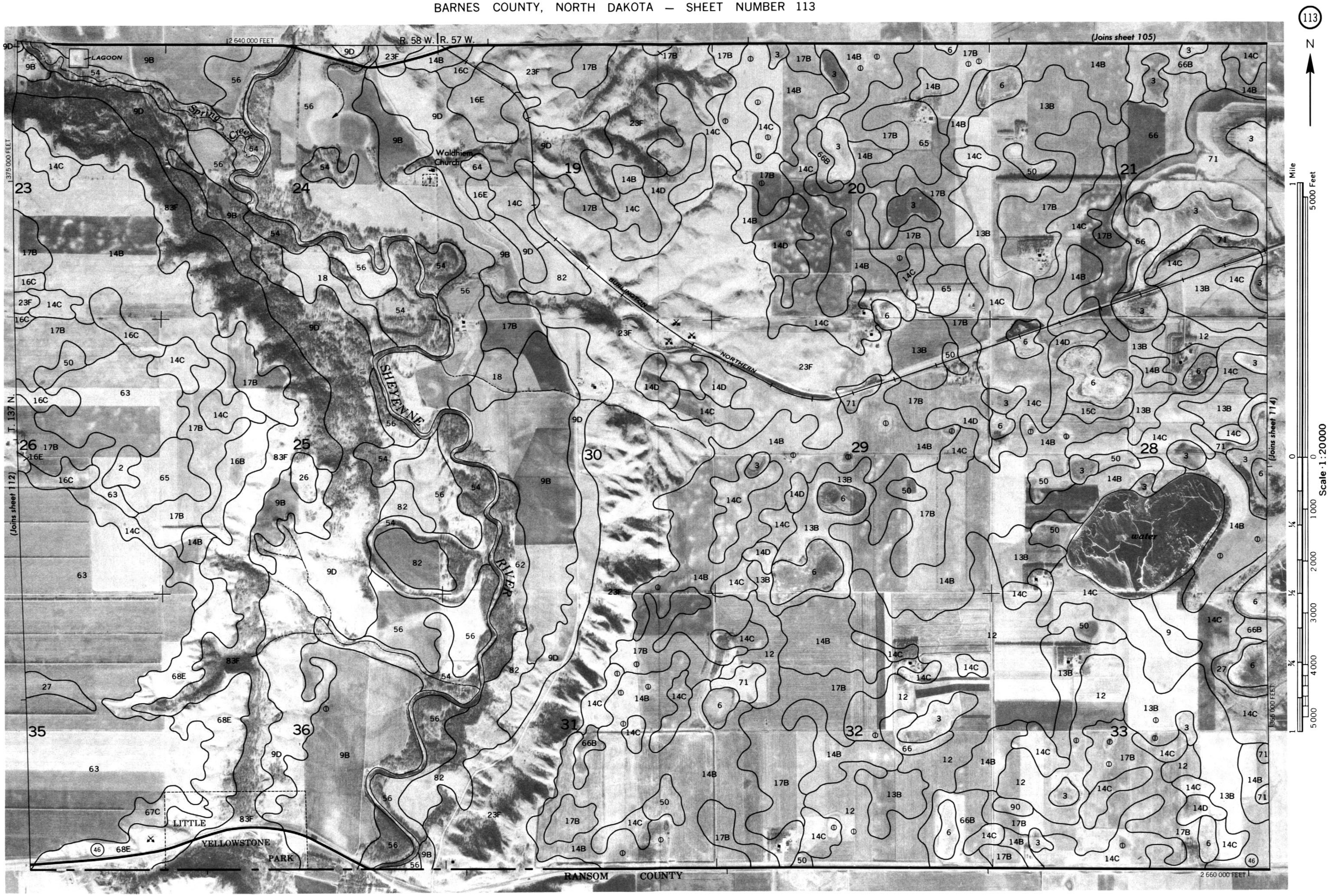
BARNES COUNTY, NORTH DAKOTA NO. 112



BARNES COUNTY, NORTH DAKOTA NO. 113
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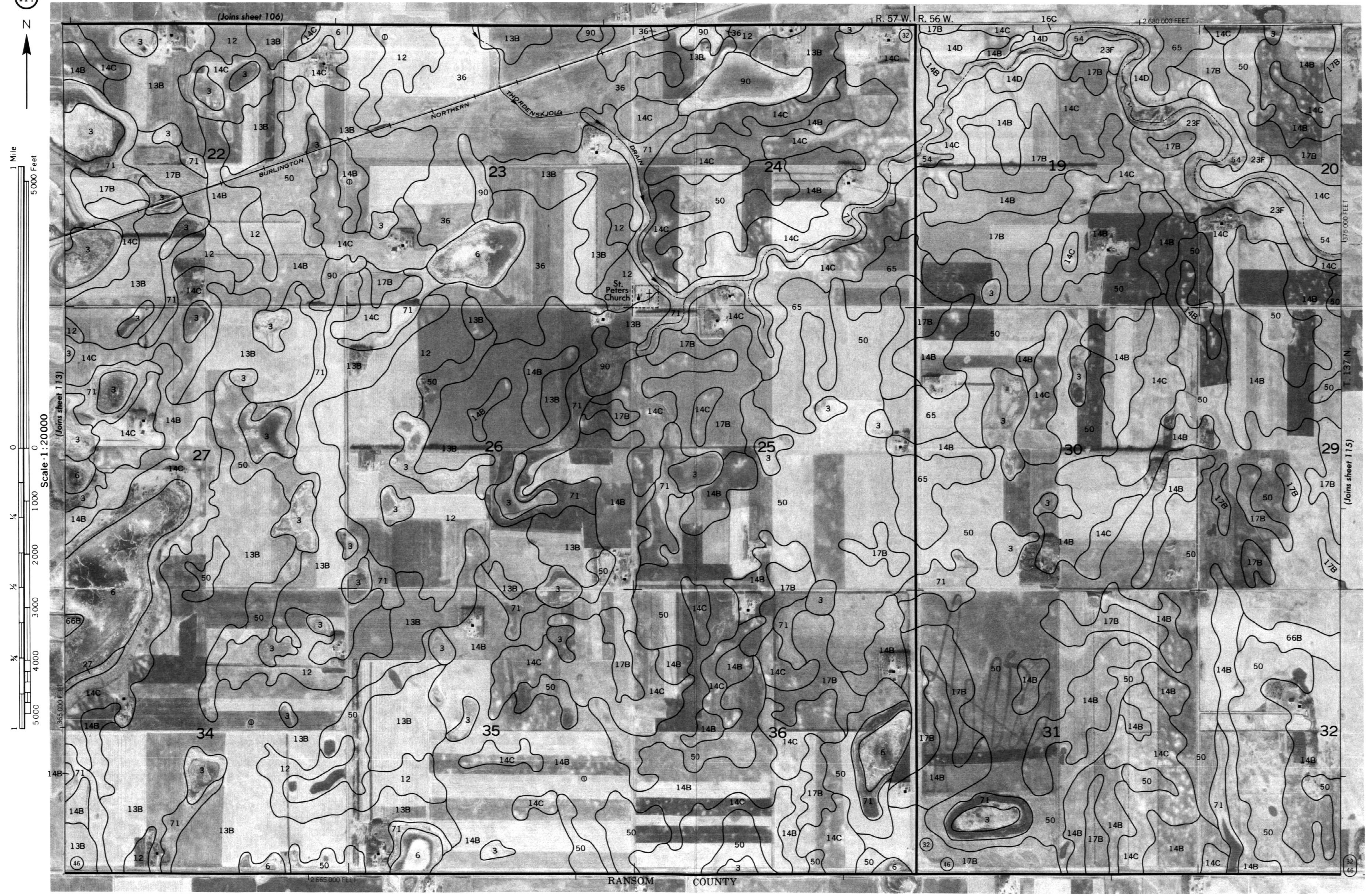

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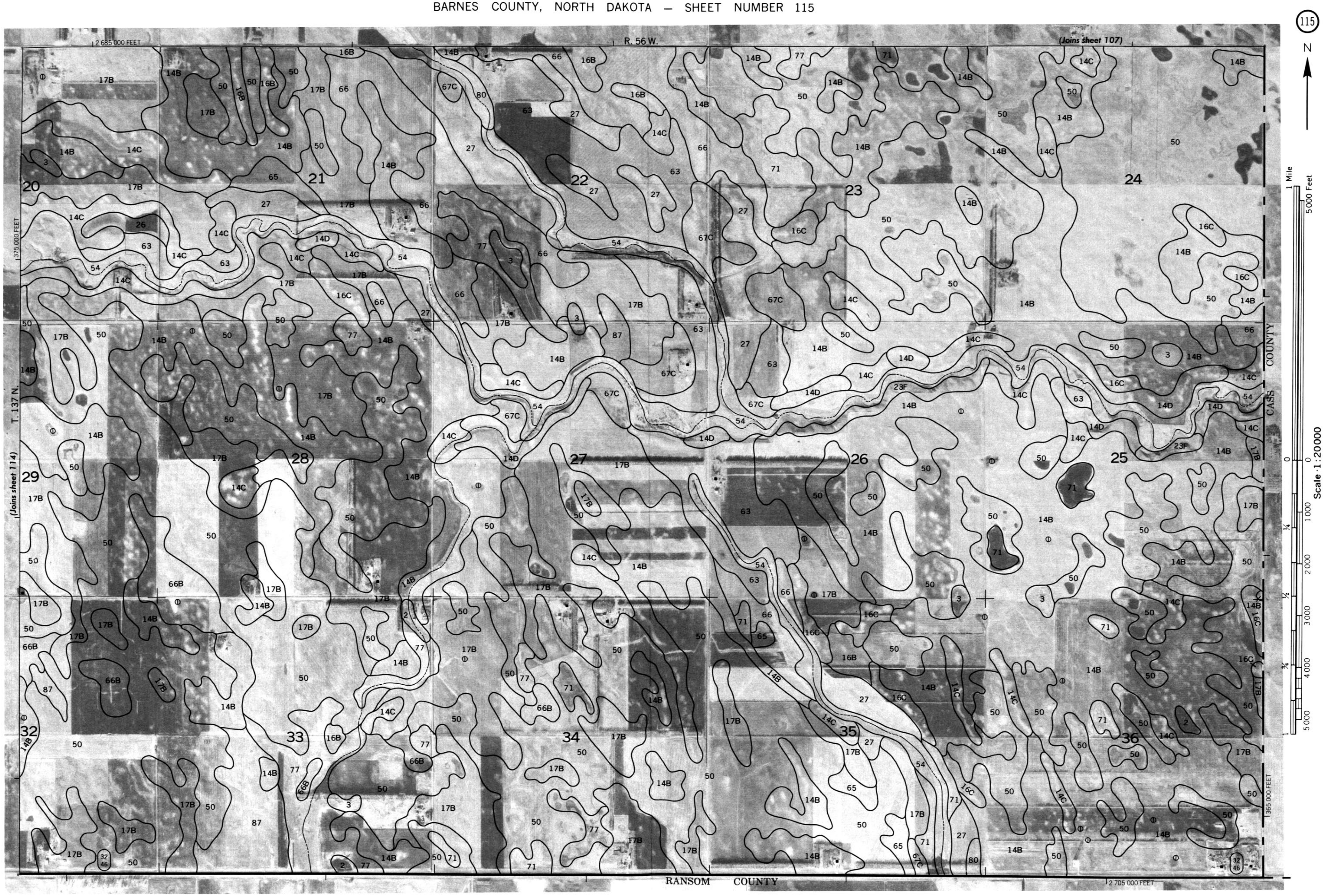
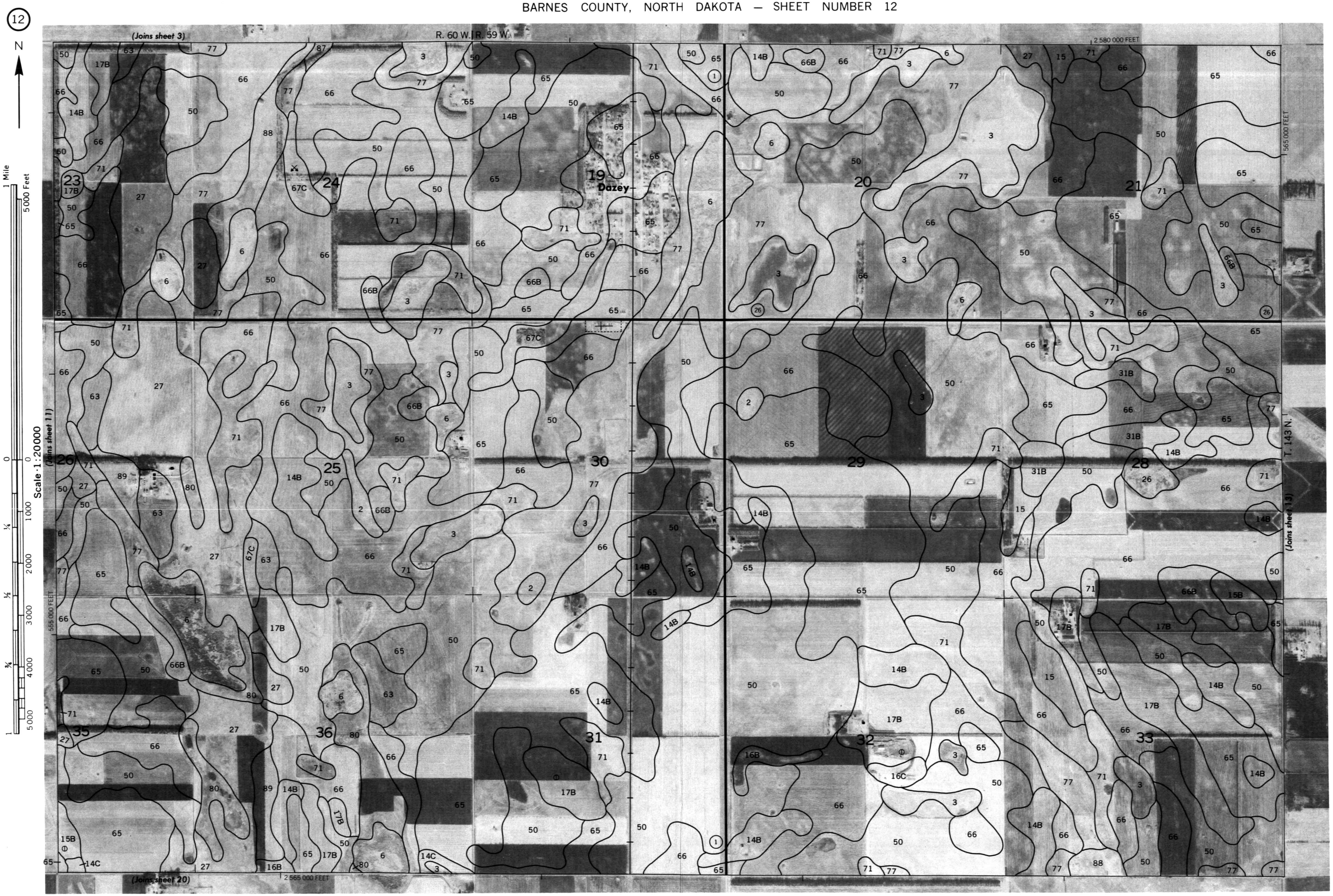
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 114



BARNES COUNTY, NORTH DAKOTA NO. 115

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

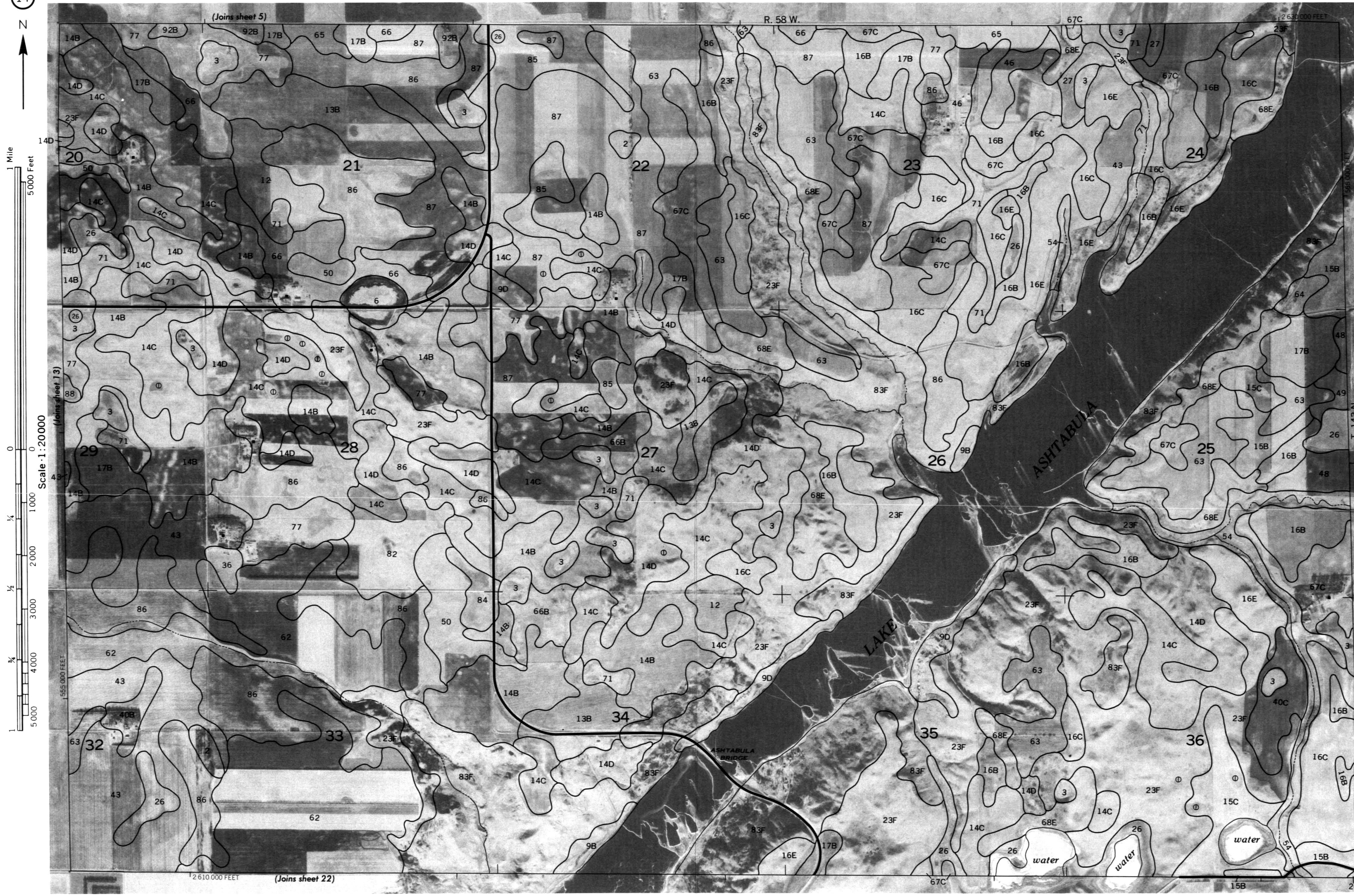
BARNES COUNTY, NORTH DAKOTA NO. 12

13

BARNES COUNTY, NORTH DAKOTA NO. 13

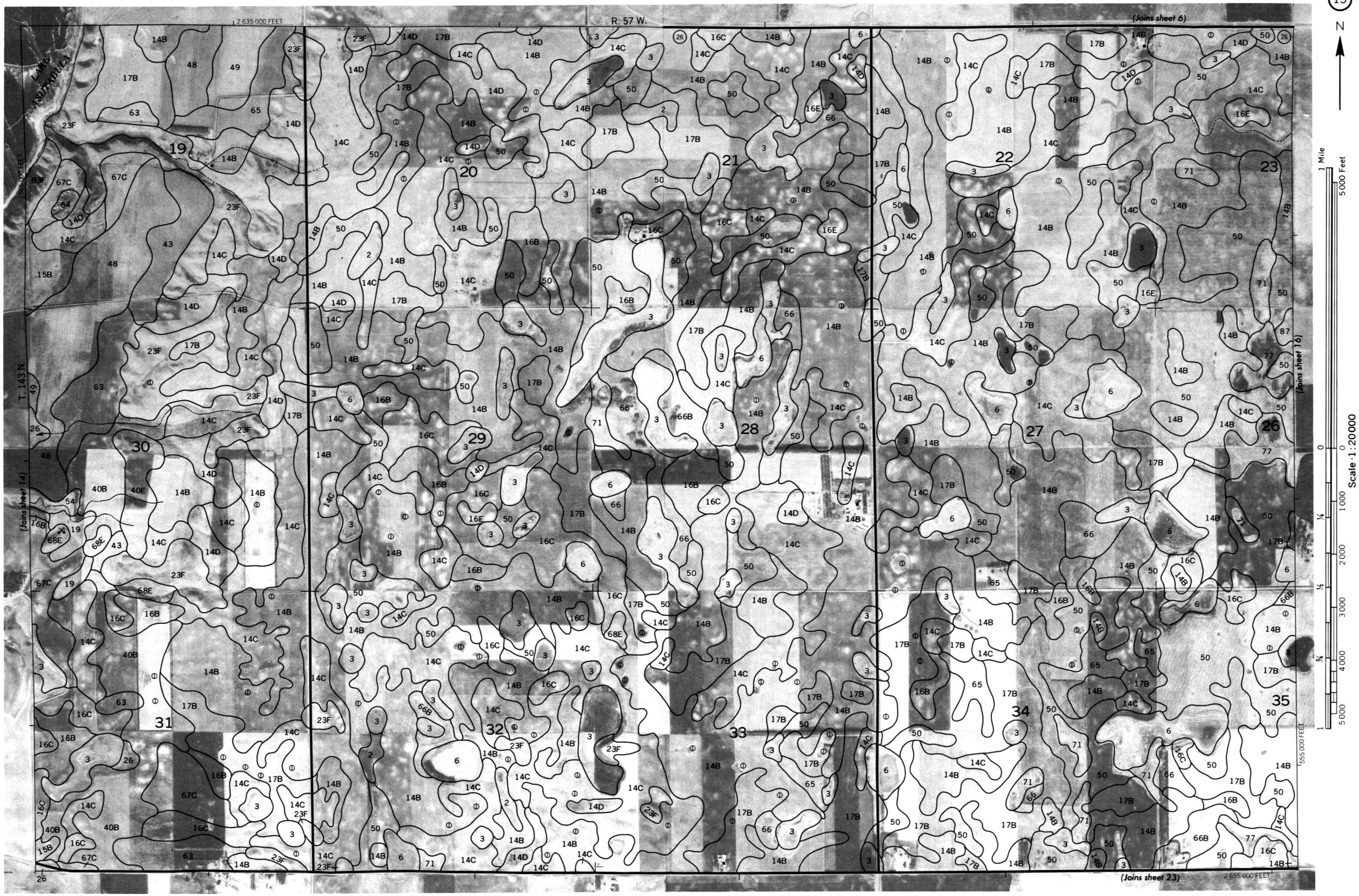
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

14



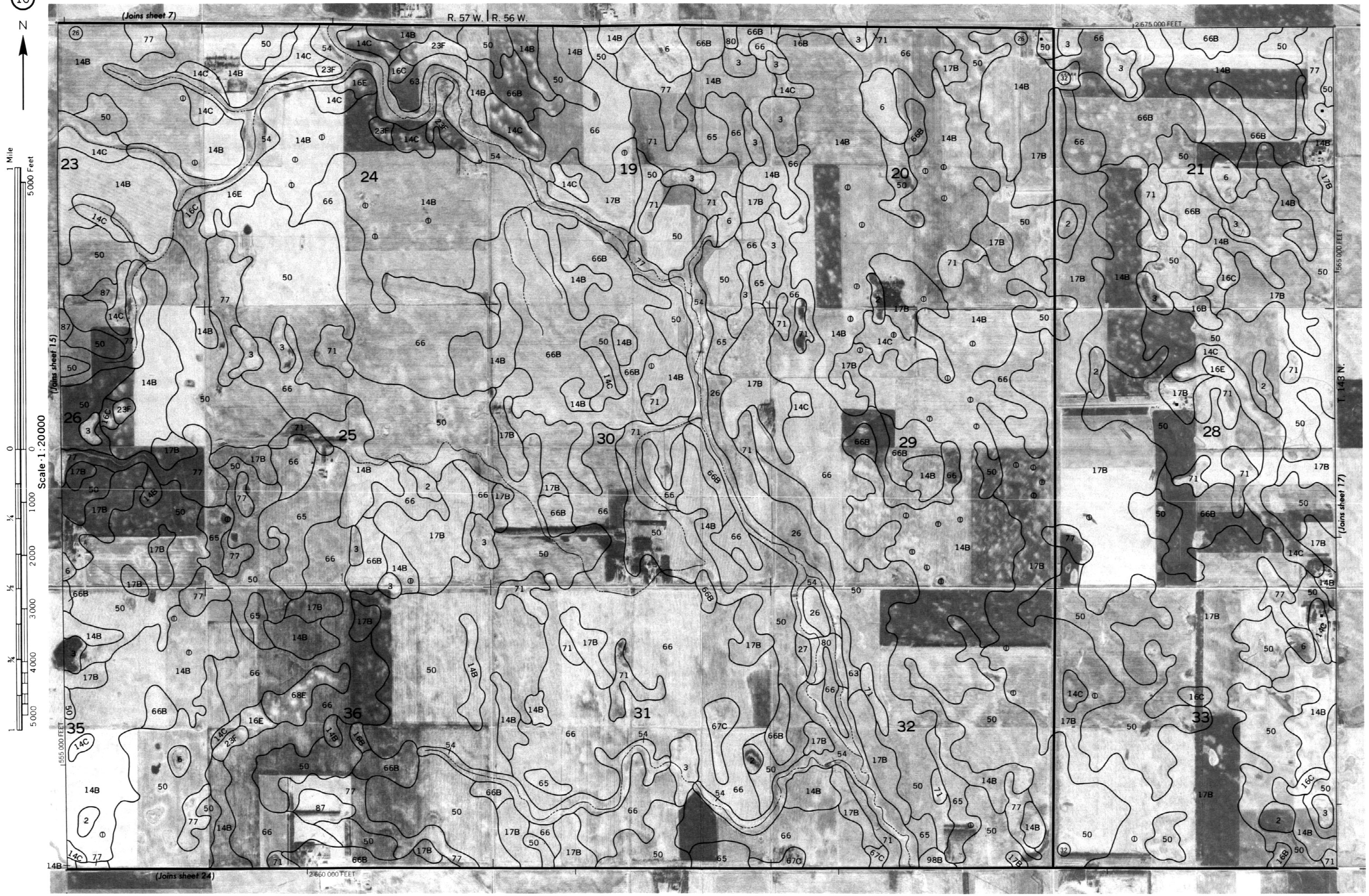
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 14



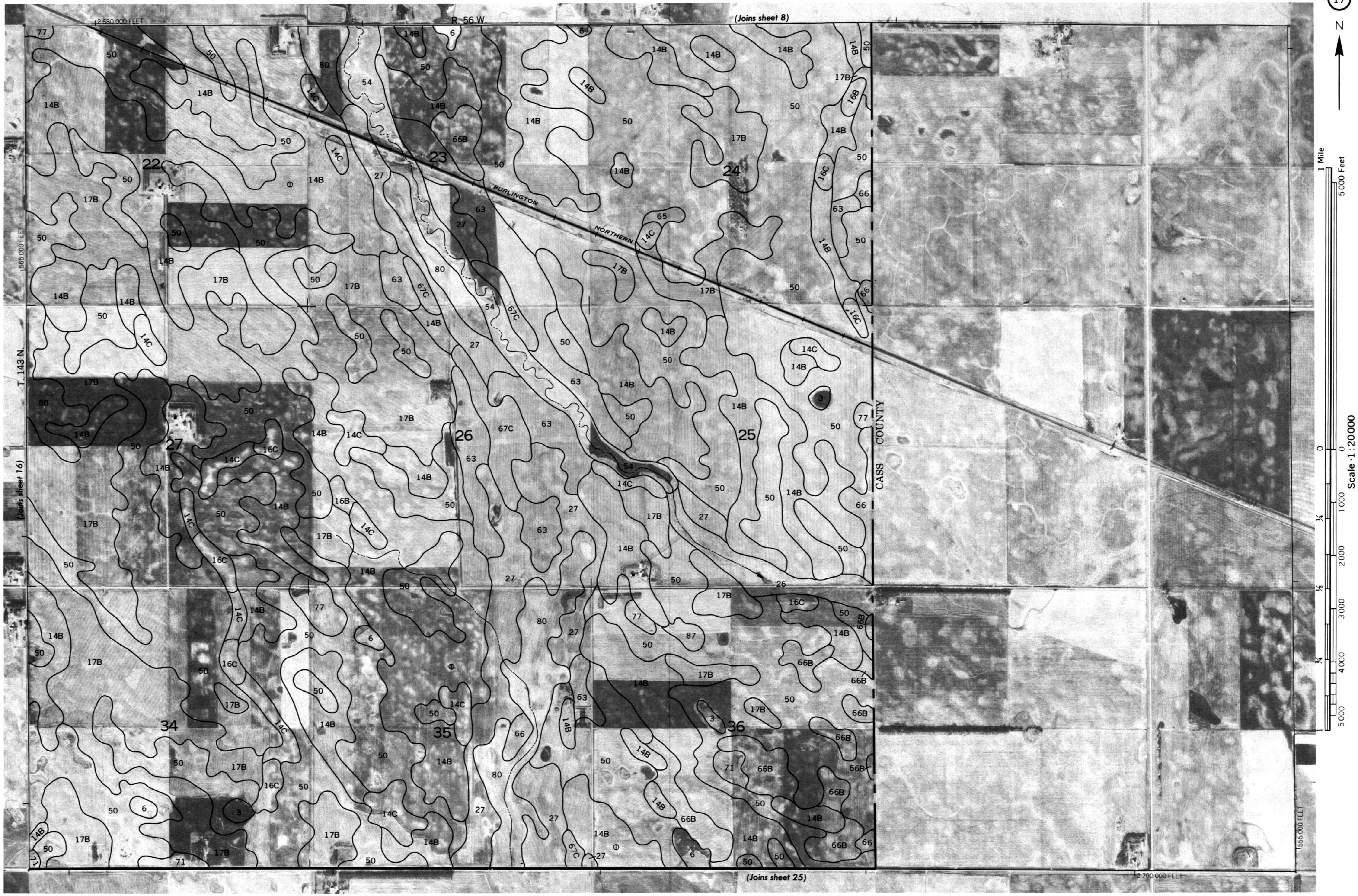
BARNES COUNTY, NORTH DAKOTA NO. 15

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



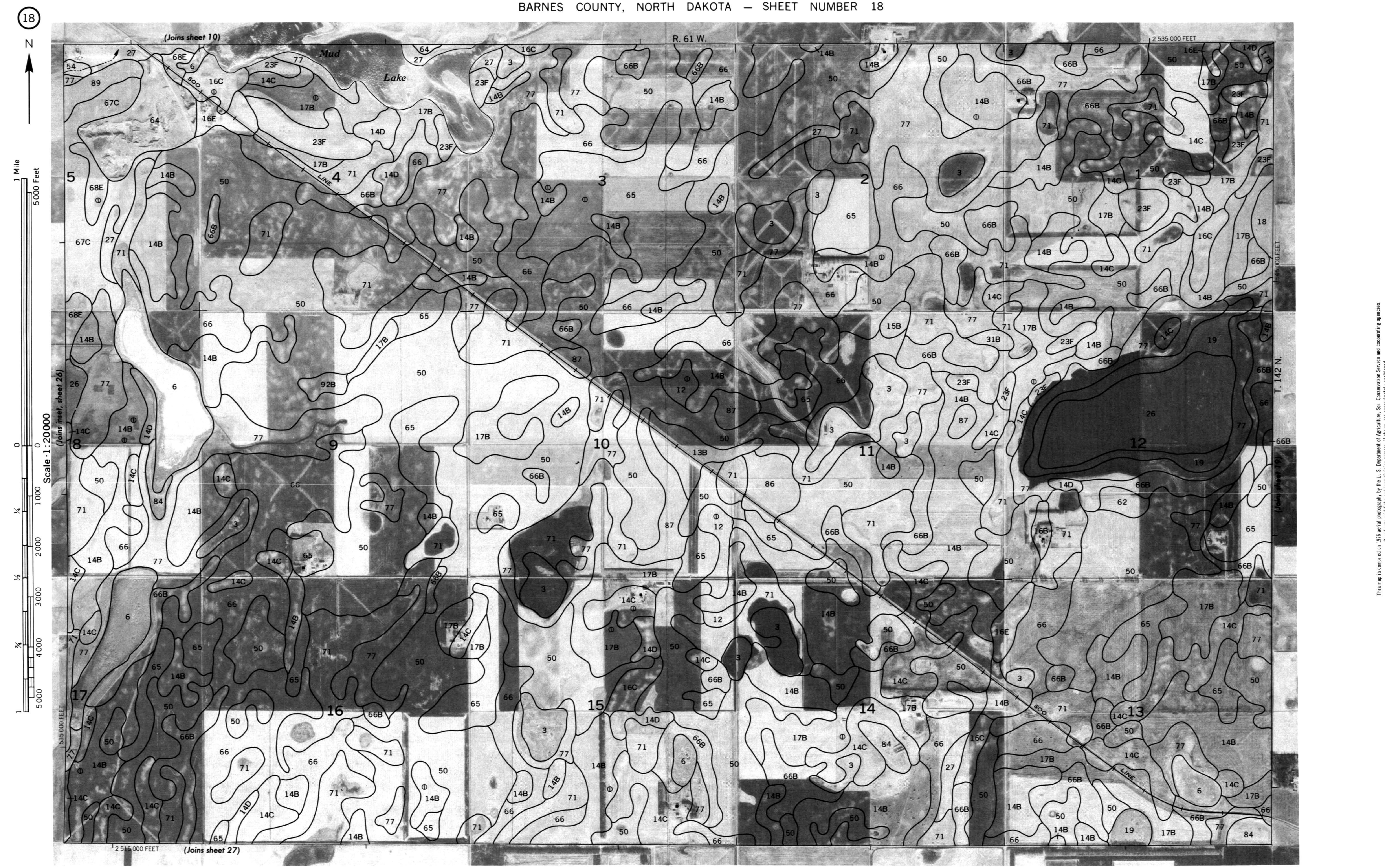
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

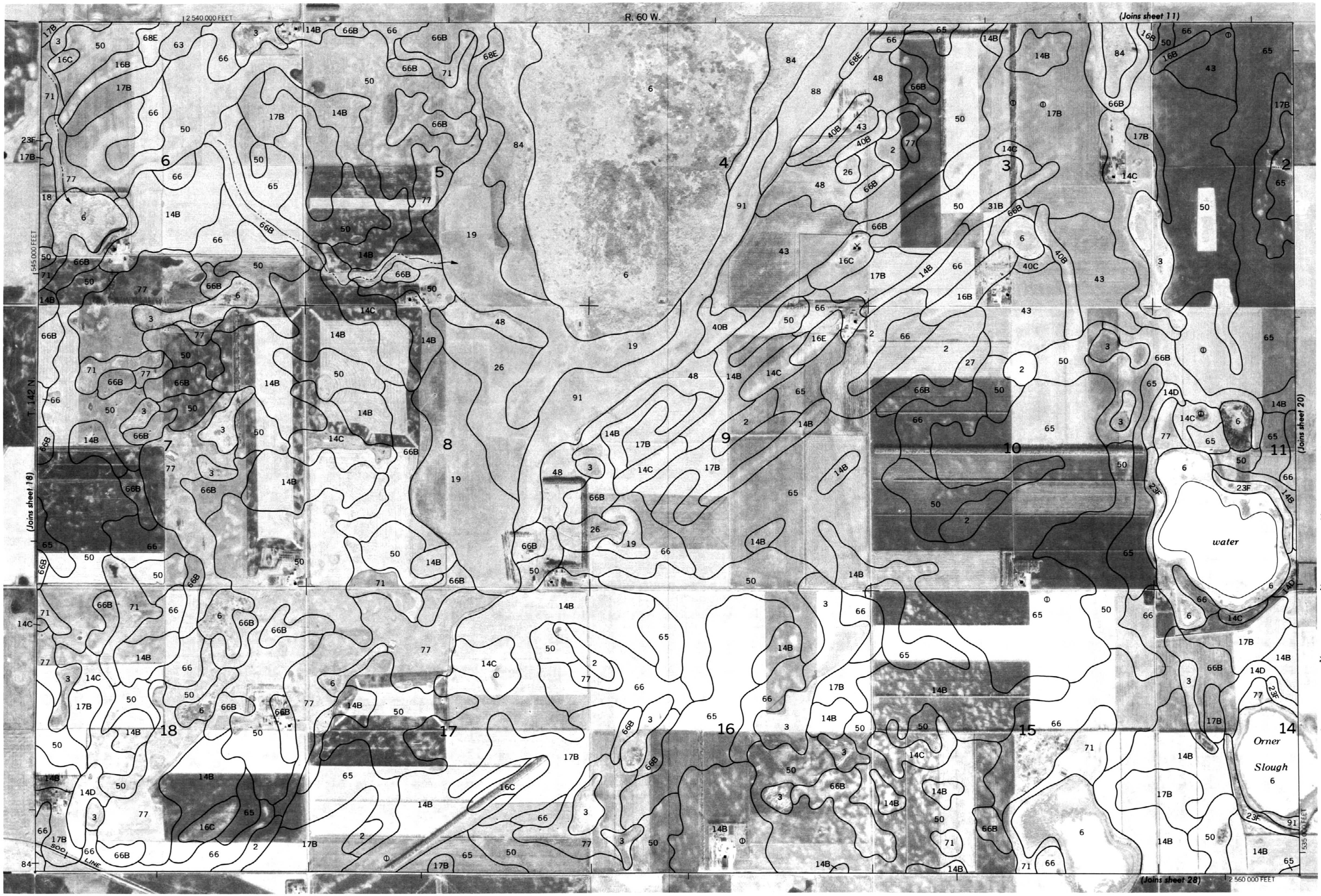
BARNES COUNTY, NORTH DAKOTA NO. 16



BARNES COUNTY, NORTH DAKOTA NO. 17

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.


18
N
(Joins sheet 10)
R. 61 W.
2 535 000 FEET
Mud
Lake
SOO LINE
(Joins inset, sheet 26)
(Joins sheet 19)
T. 142 N.
(Joins sheet 27)
2 515 000 FEET
Scale 1:20000
1 Mile
5000 Feet
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.
BARNES COUNTY, NORTH DAKOTA NO. 18



N

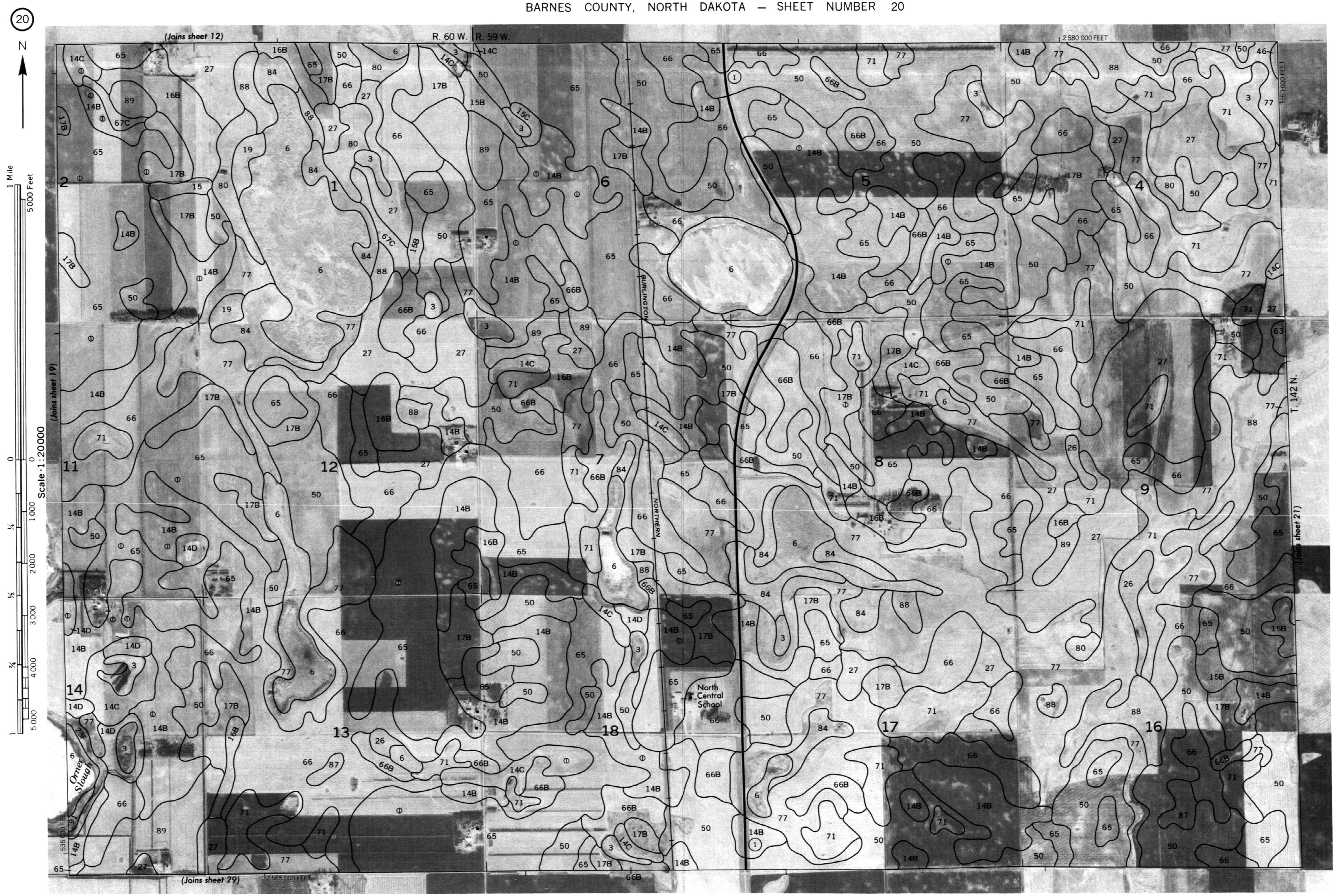
Scale 1:20000

1 Mile

5000 Feet

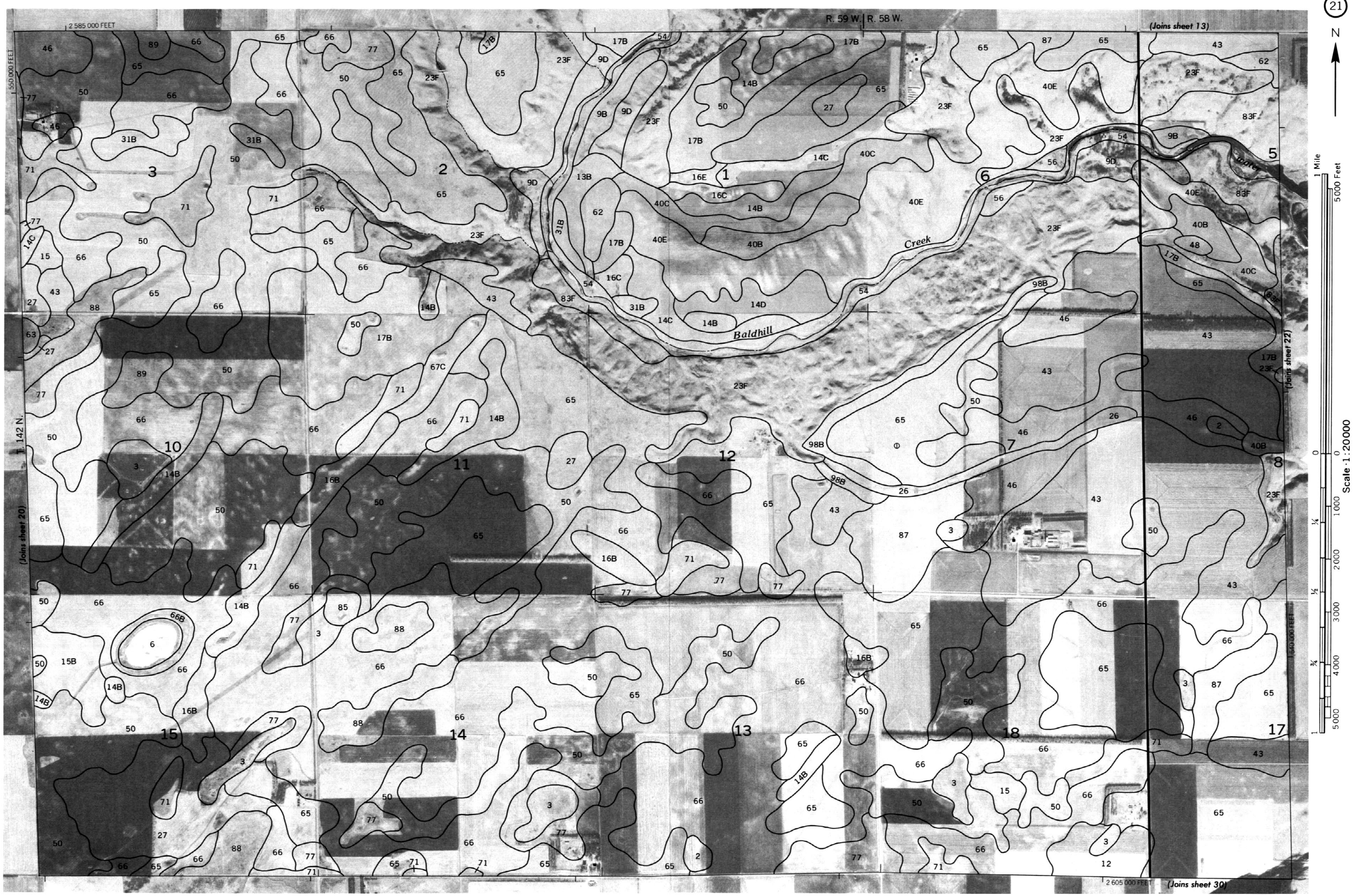
BARNES COUNTY, NORTH DAKOTA NO. 19

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



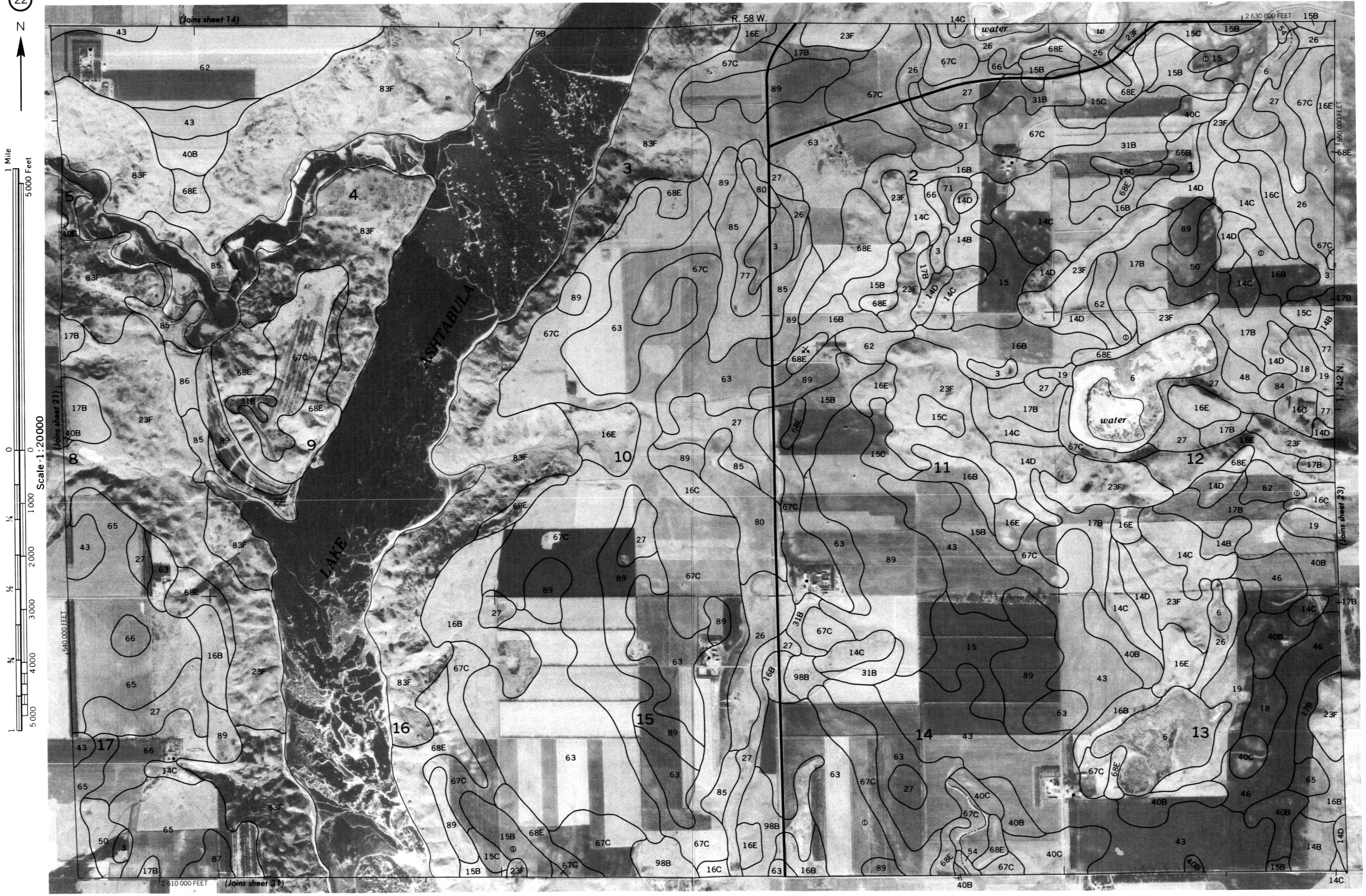
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 20



BARNES COUNTY, NORTH DAKOTA NO. 21

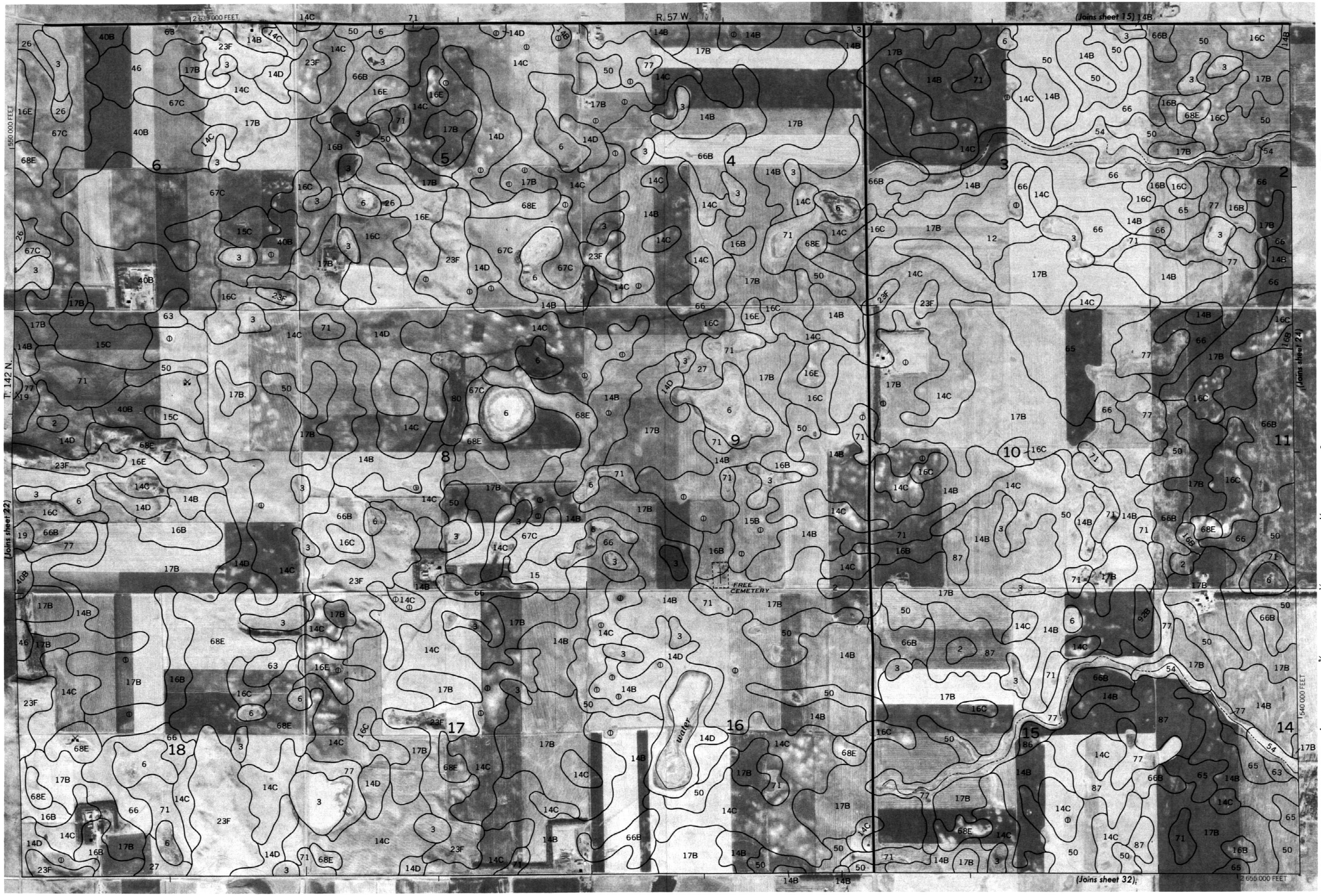
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 22

23



N

1 Mile

5000 Feet

Scale 1:20000

0 1000 2000 3000 4000 5000

0 ¼ ½ ¾ 1

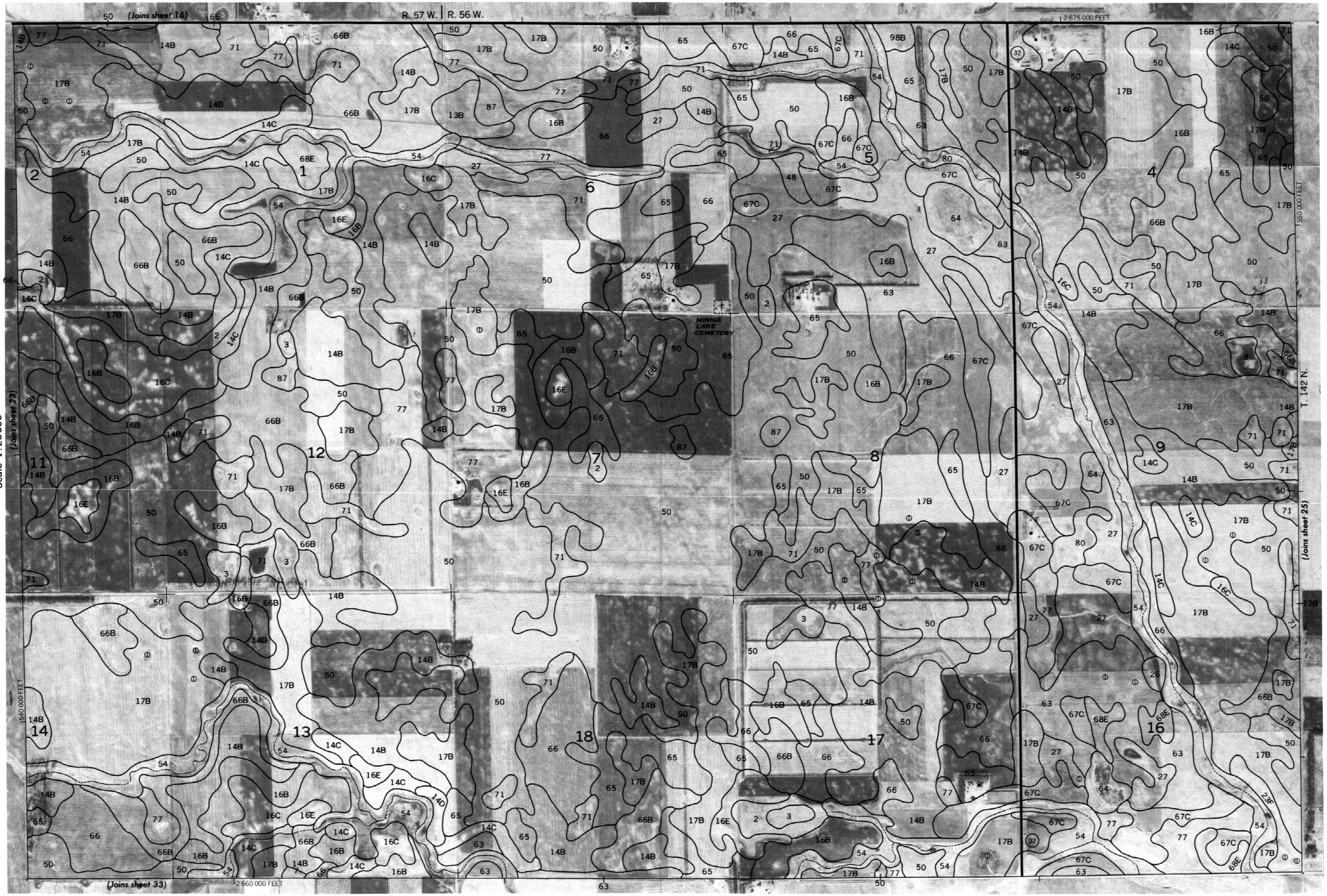
BARNES COUNTY, NORTH DAKOTA NO. 23

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

24

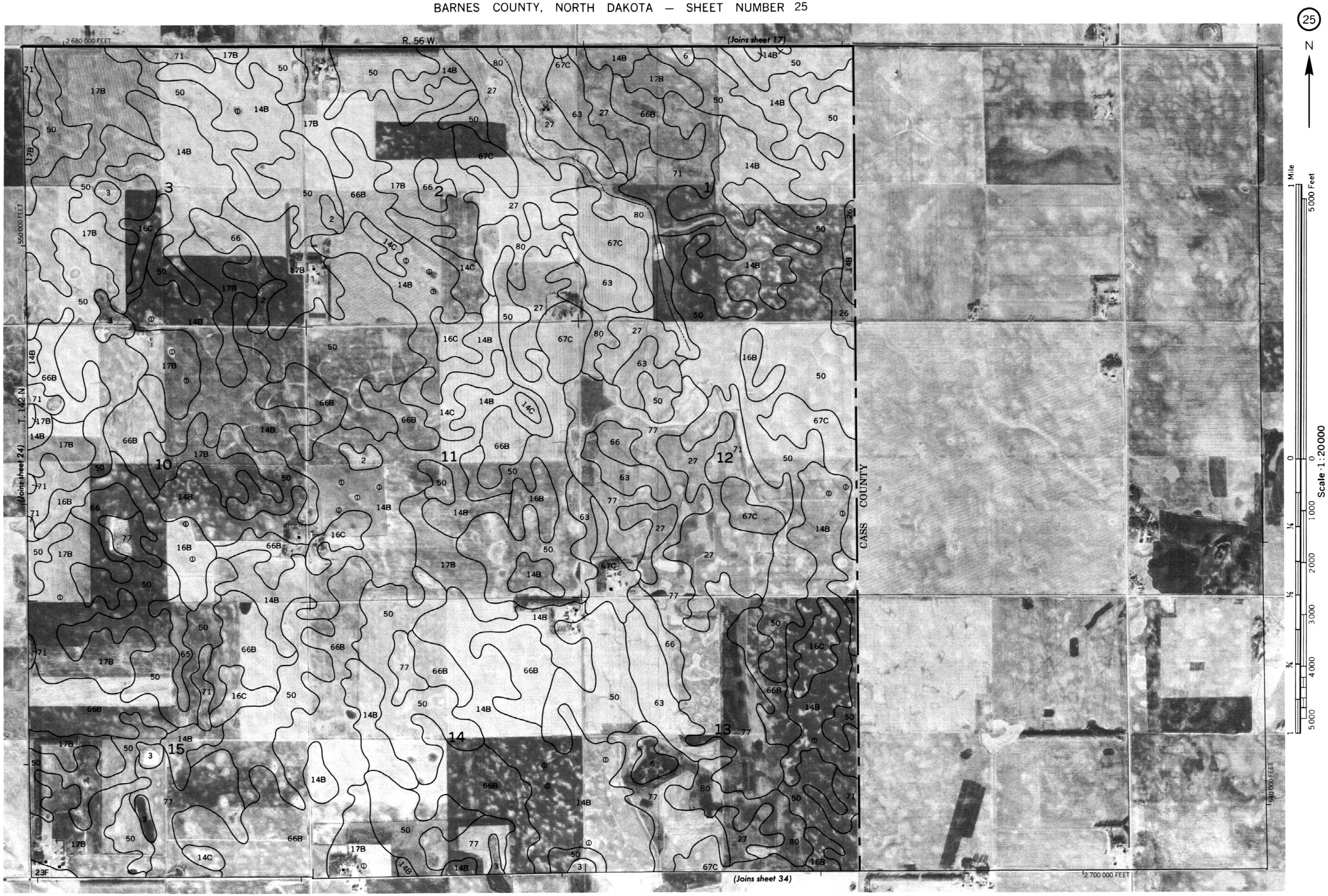
N

1 Mile
5 000 Feet
0
Scale 1:20000
1000
2000
3000
4000
5000



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 24

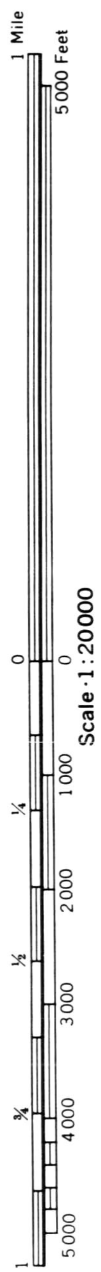


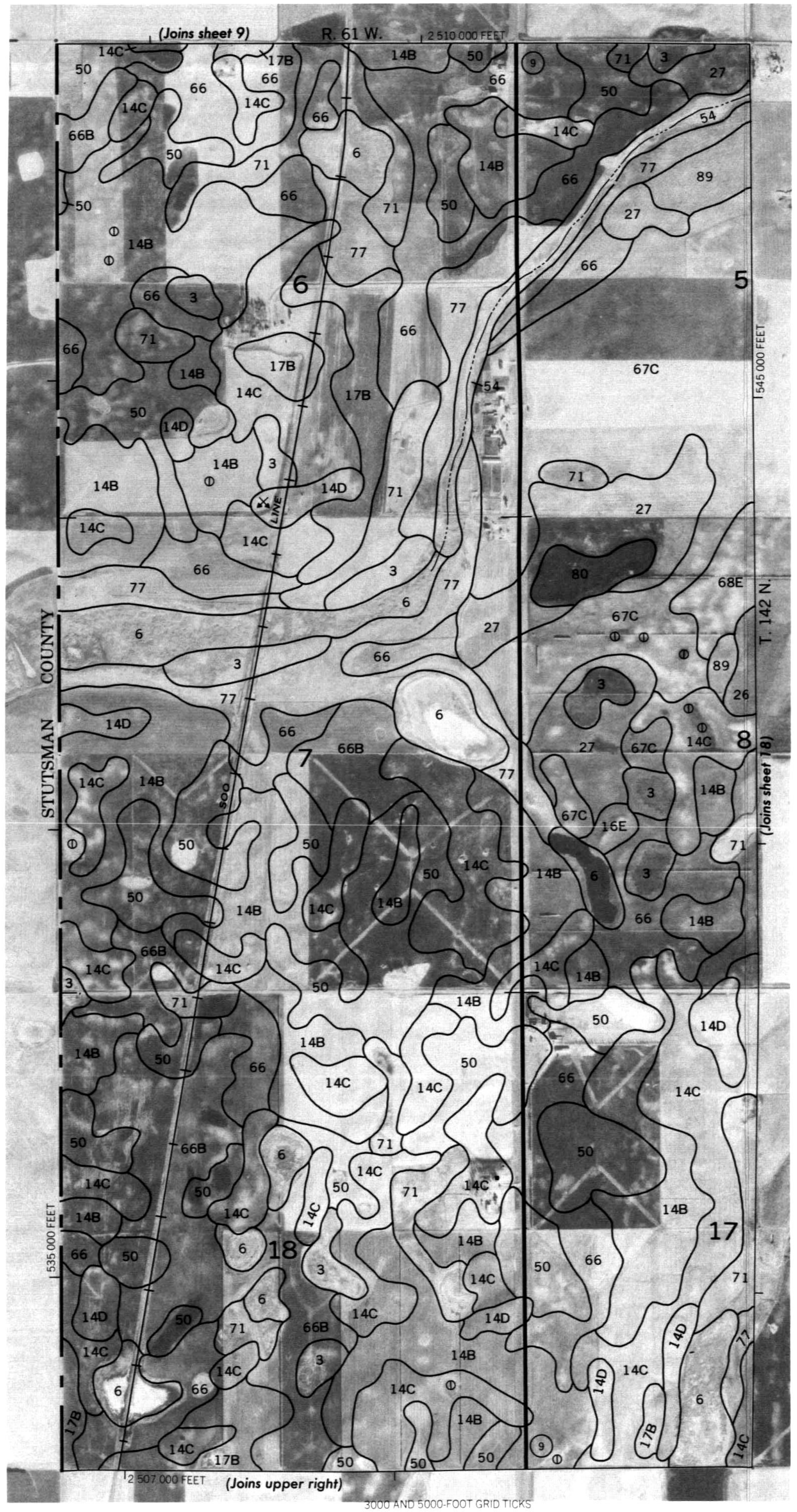
BARNES COUNTY, NORTH DAKOTA NO. 25

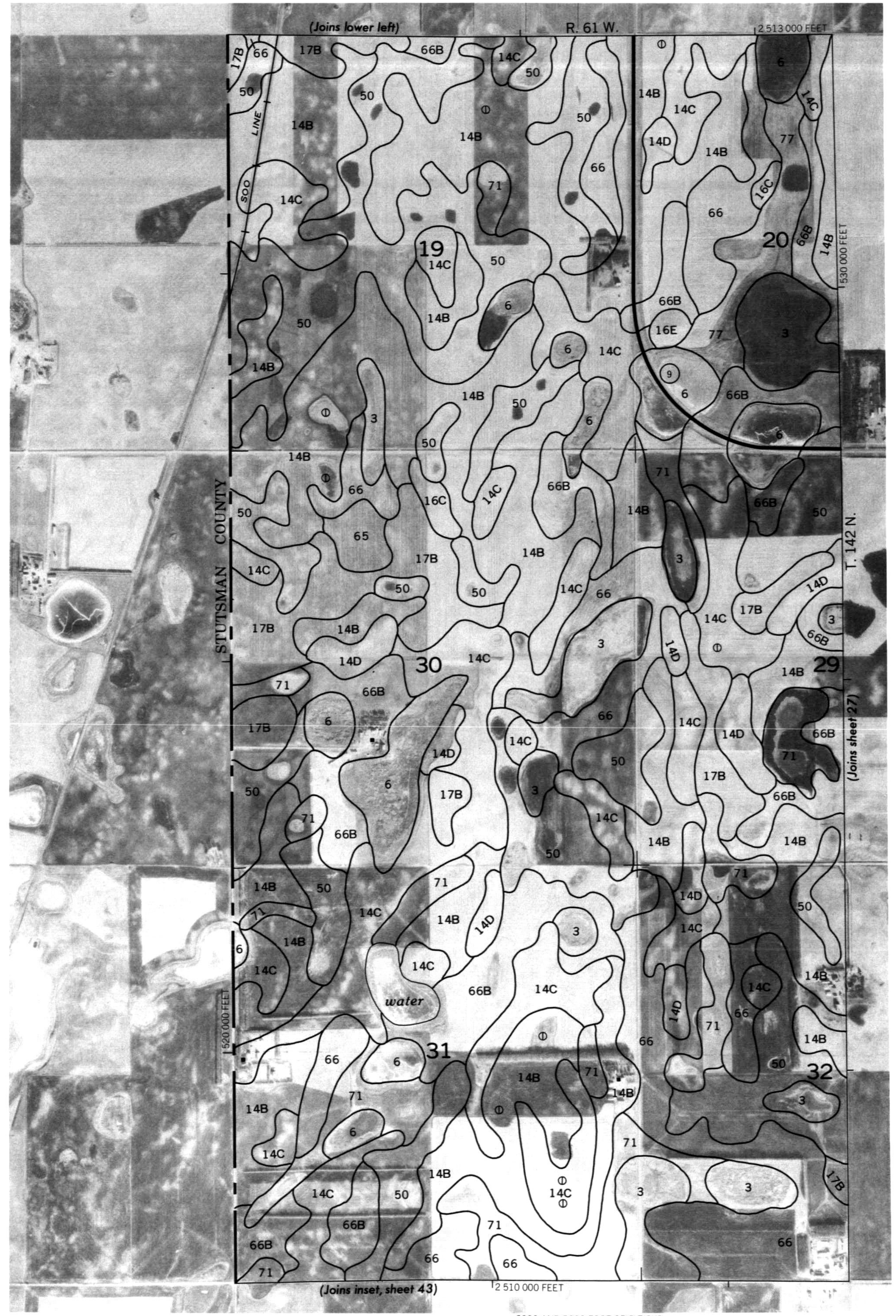
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

26

N



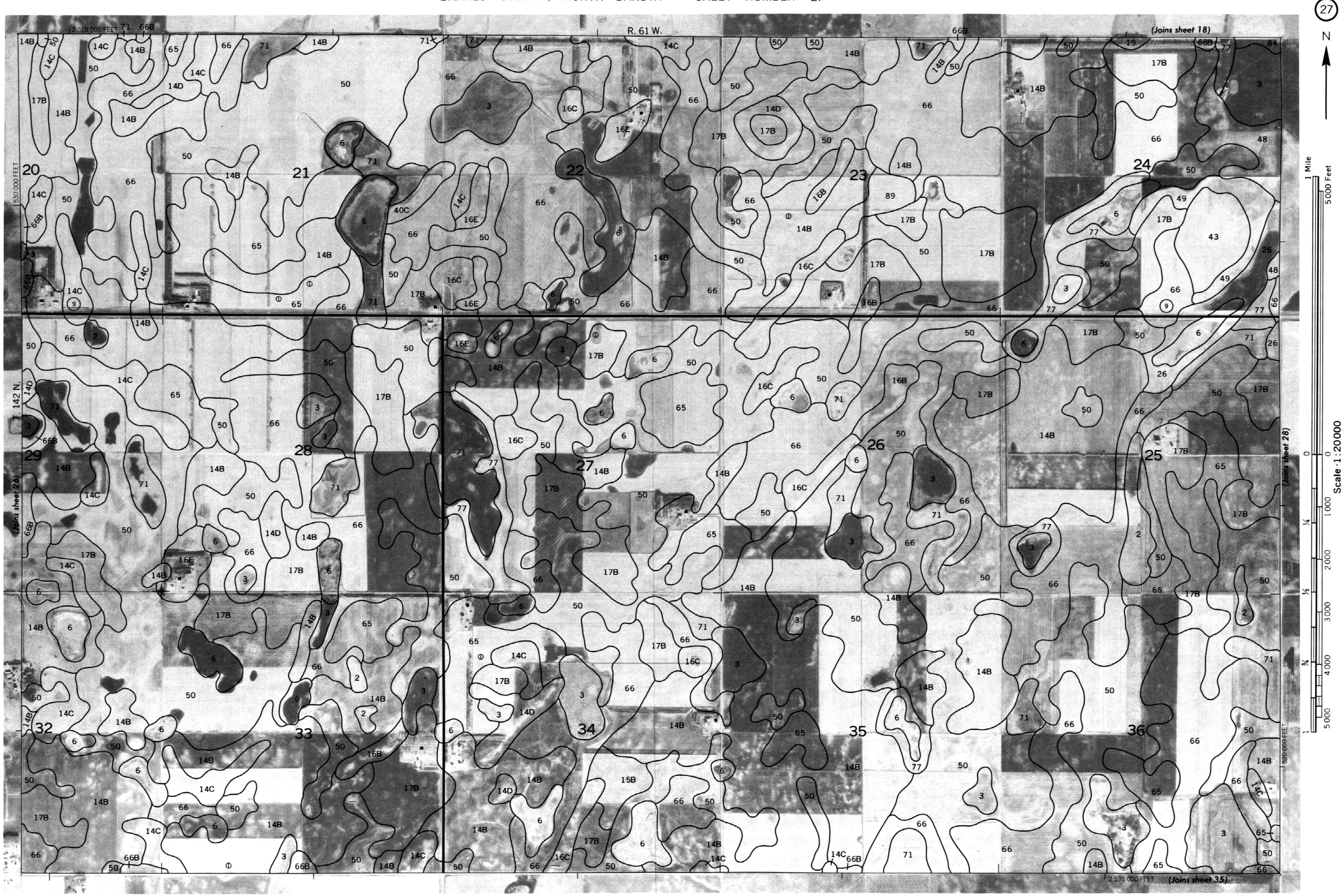


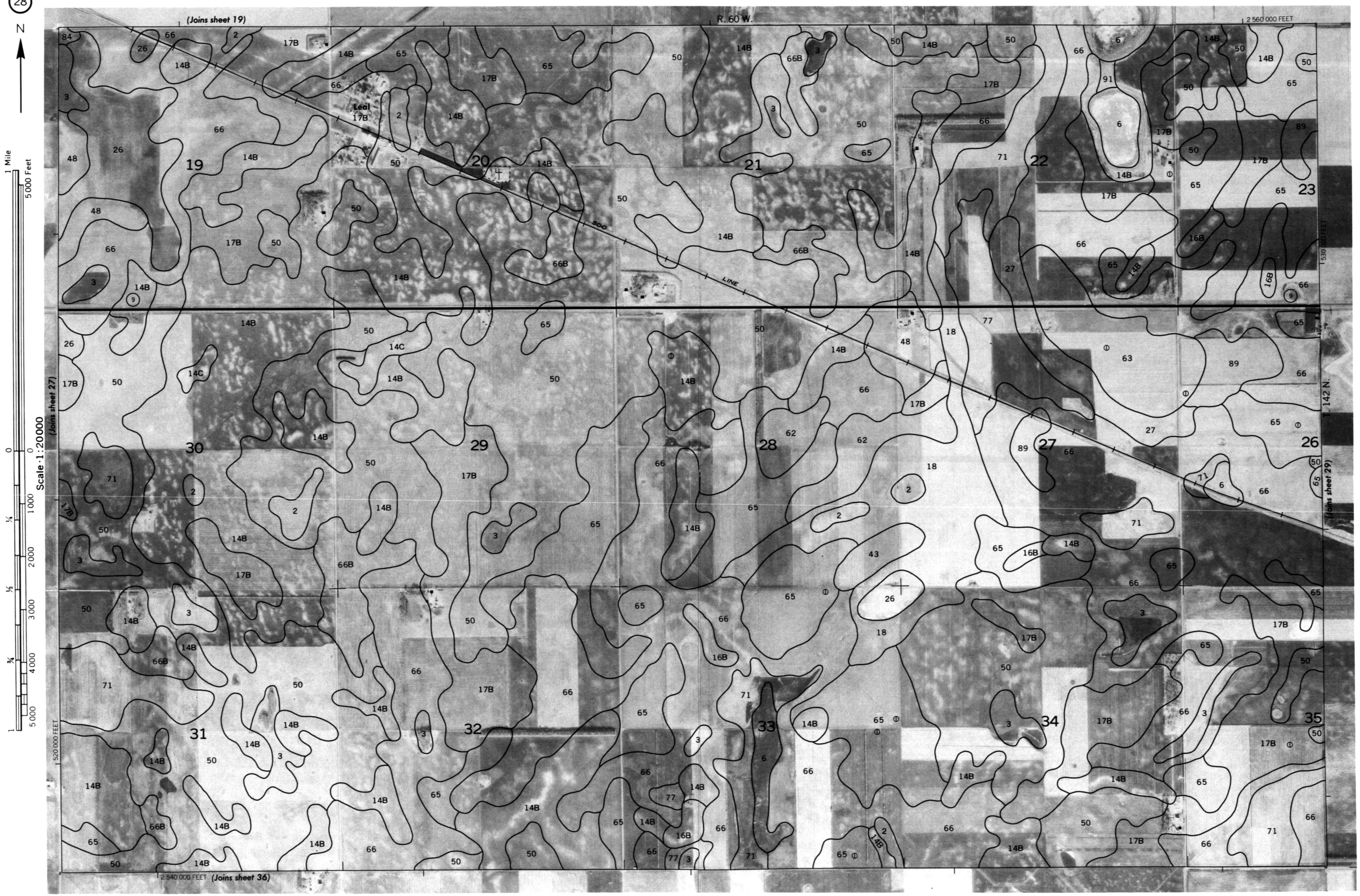


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 27

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



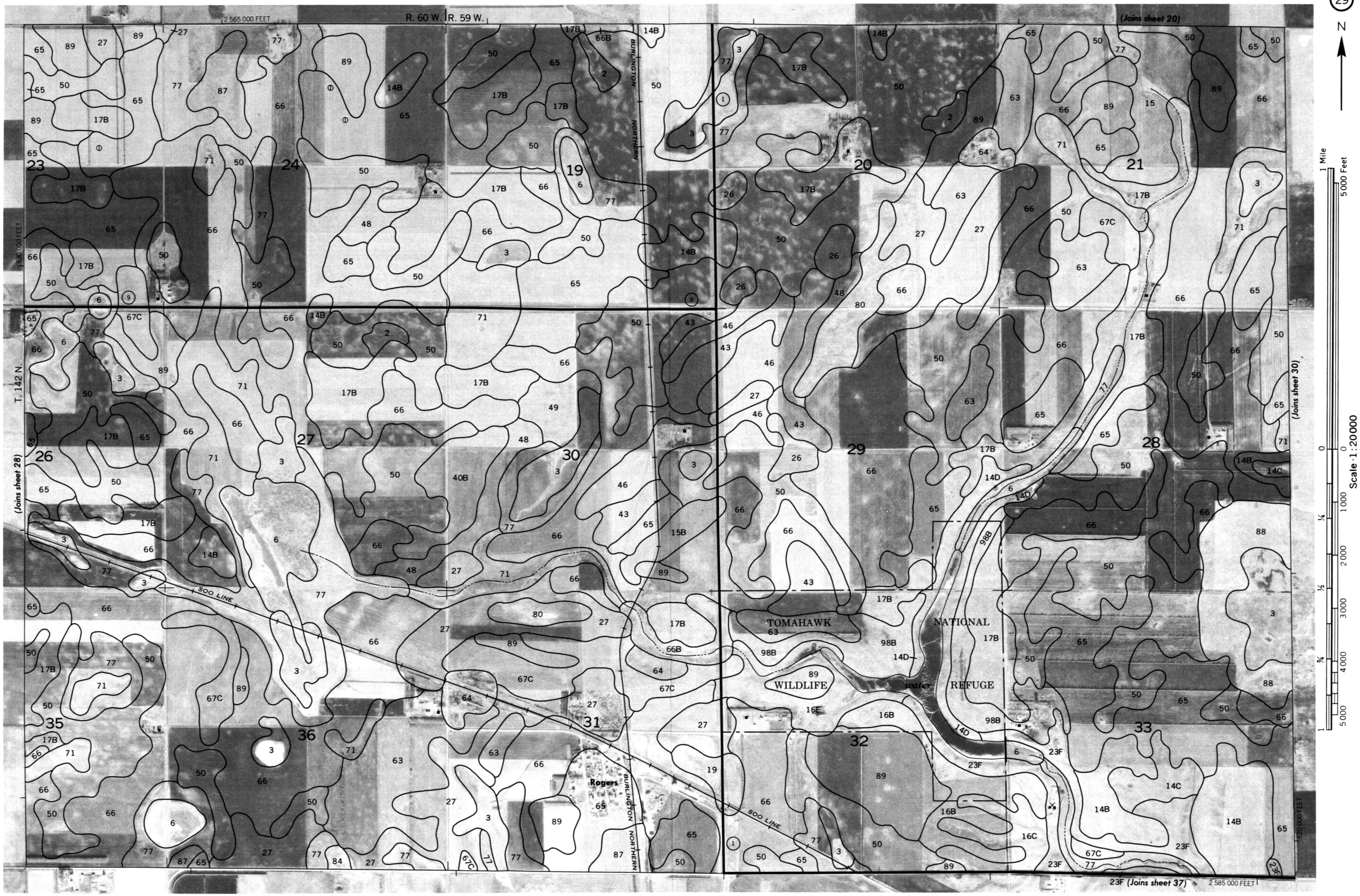


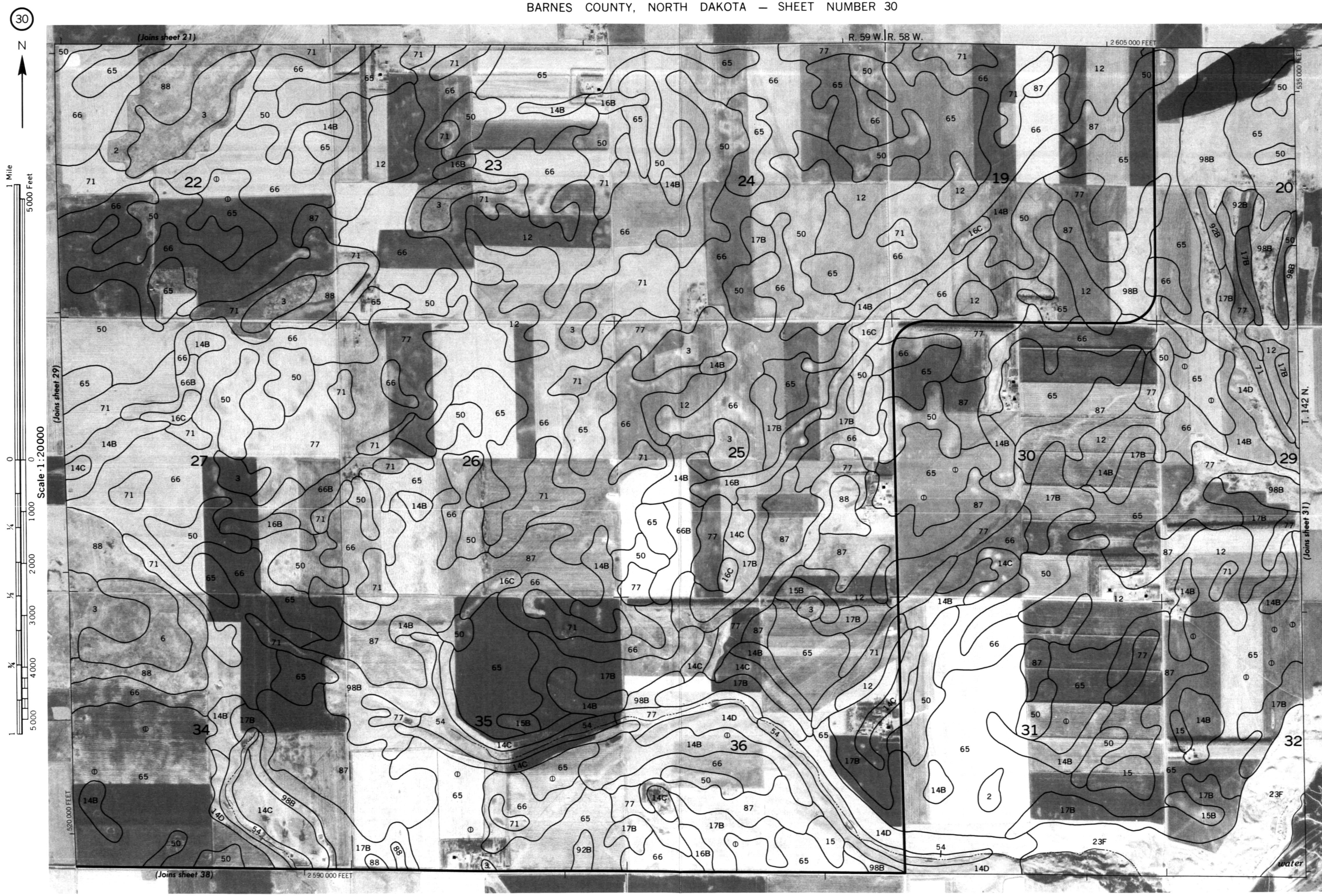
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 28

BARNES COUNTY, NORTH DAKOTA NO. 29

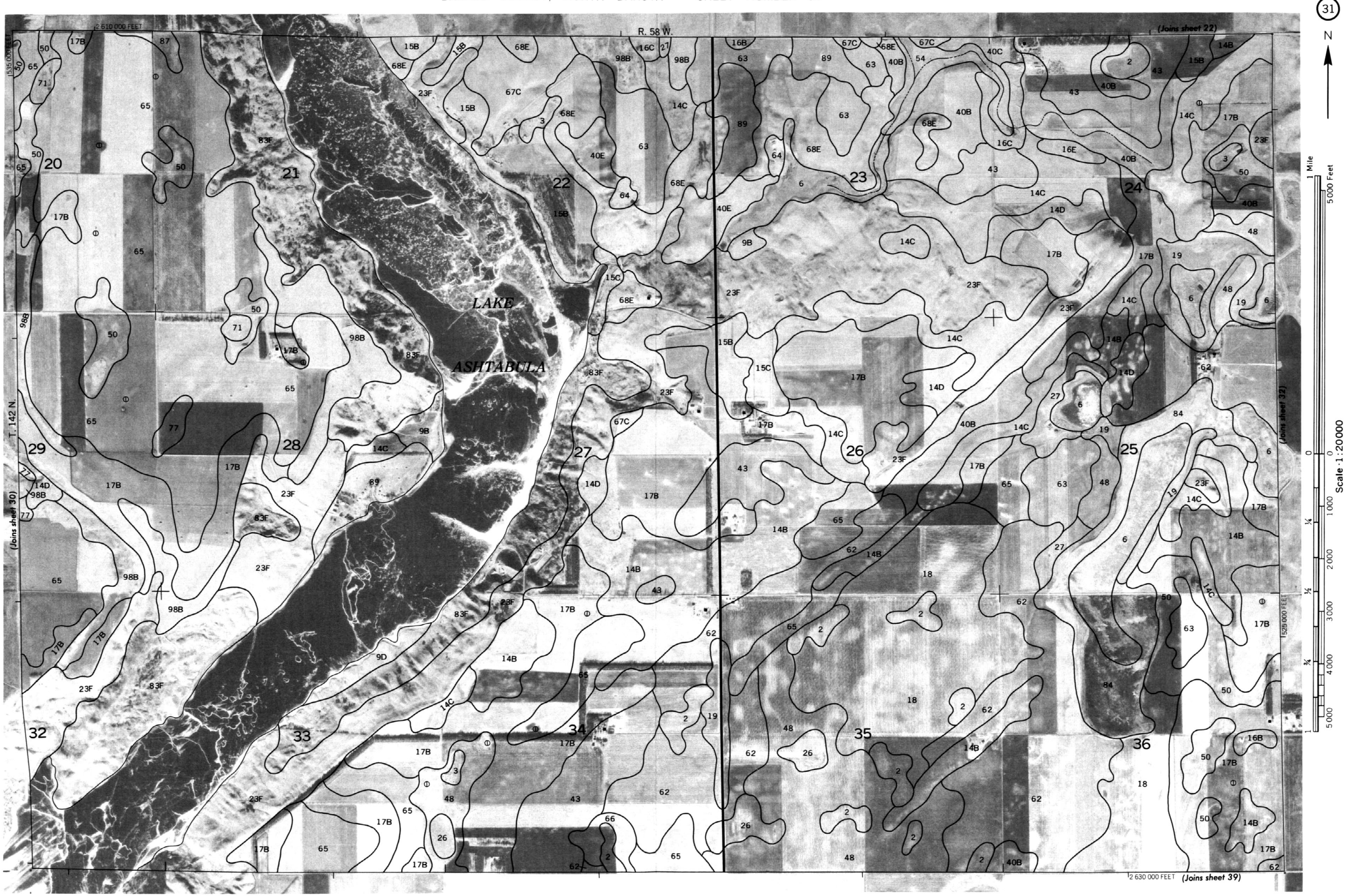
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

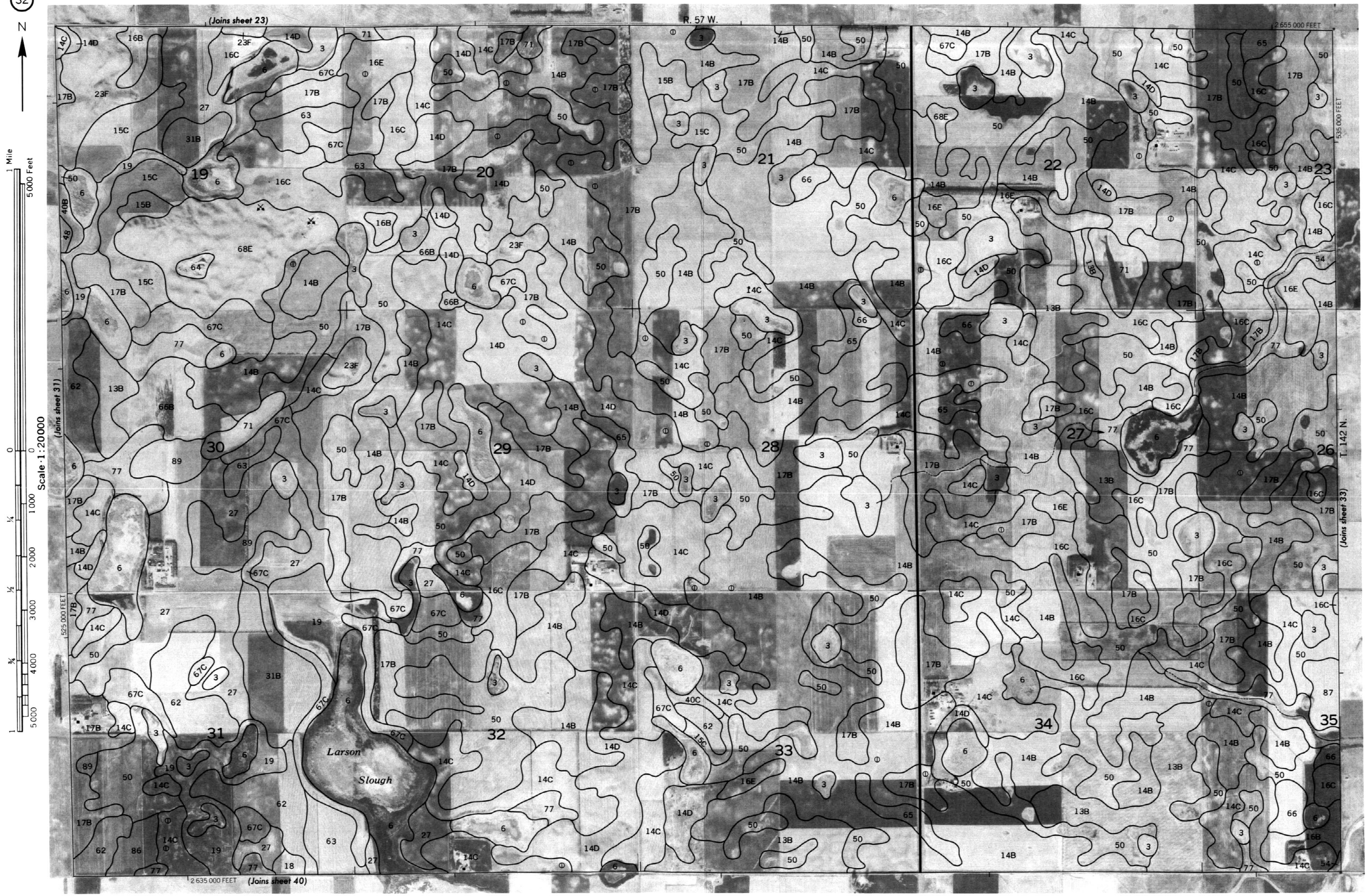
BARNES COUNTY, NORTH DAKOTA NO. 30



BARNES COUNTY, NORTH DAKOTA NO. 31

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

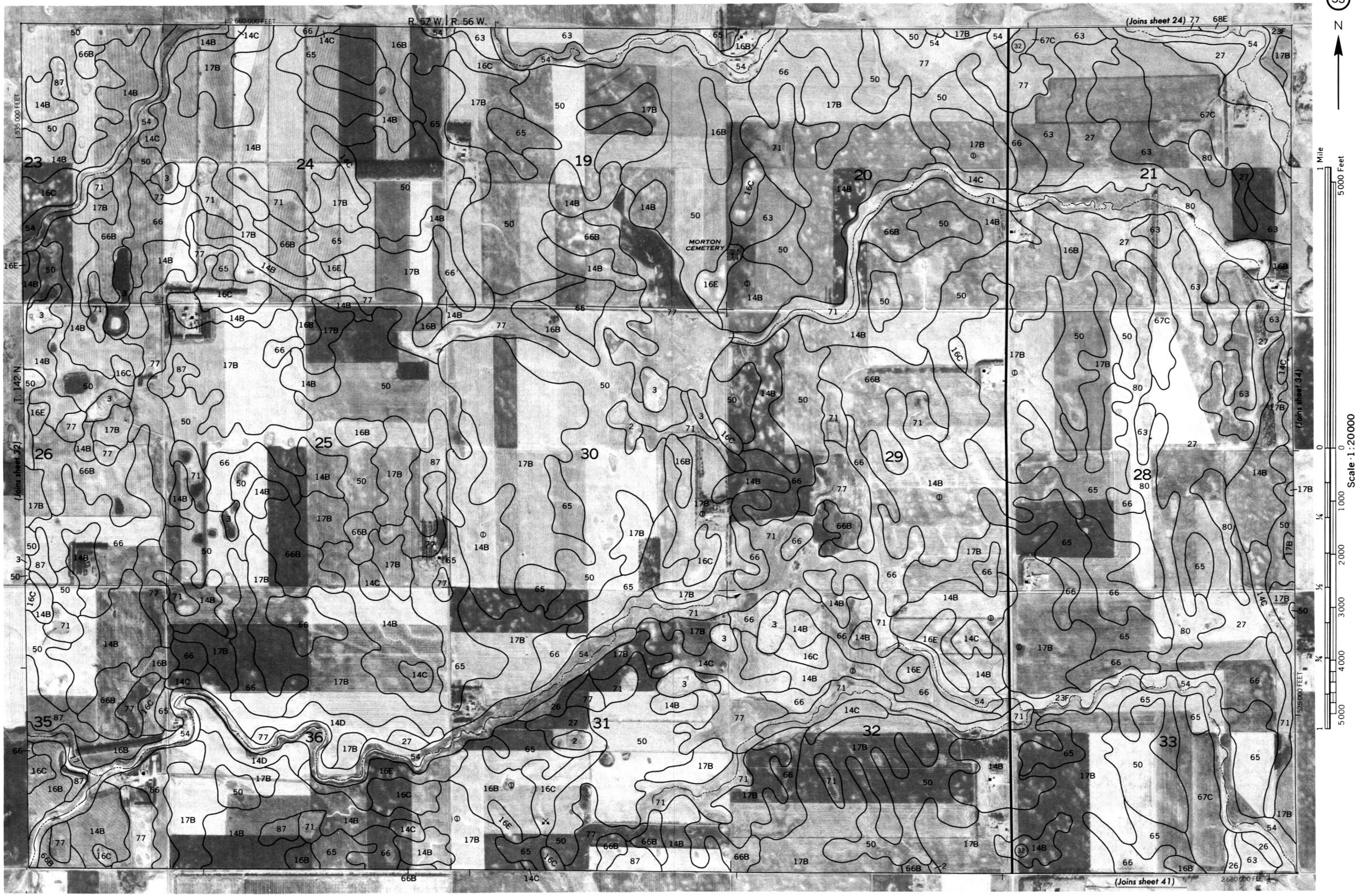
BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 32



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 32

33

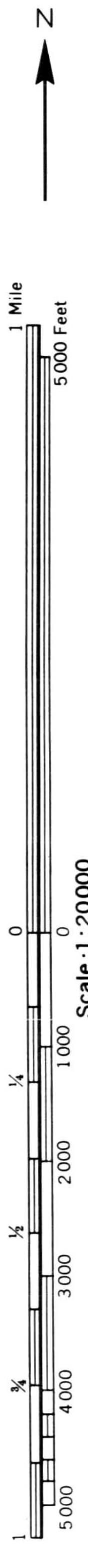


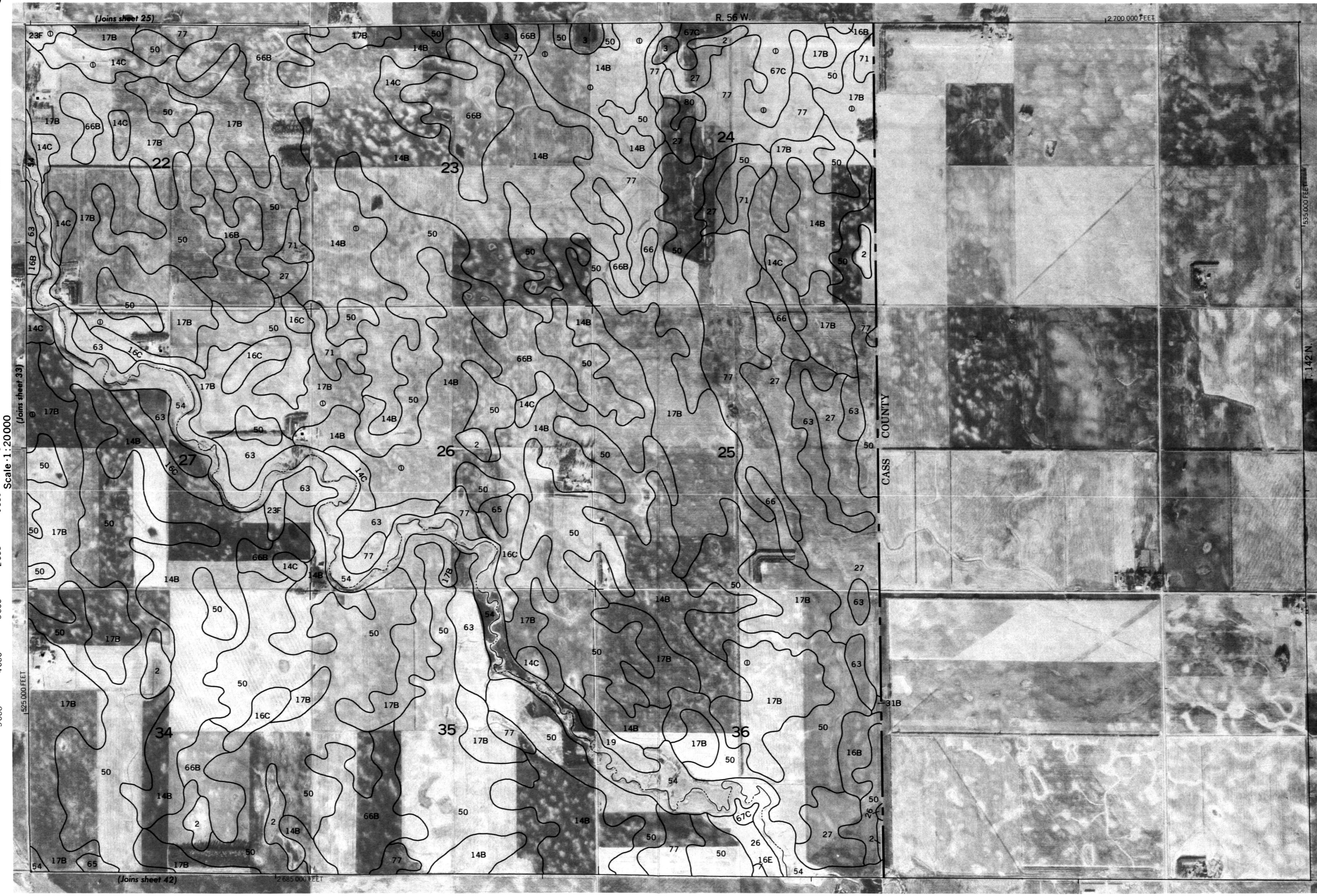
BARNES COUNTY, NORTH DAKOTA NO. 33

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(34)

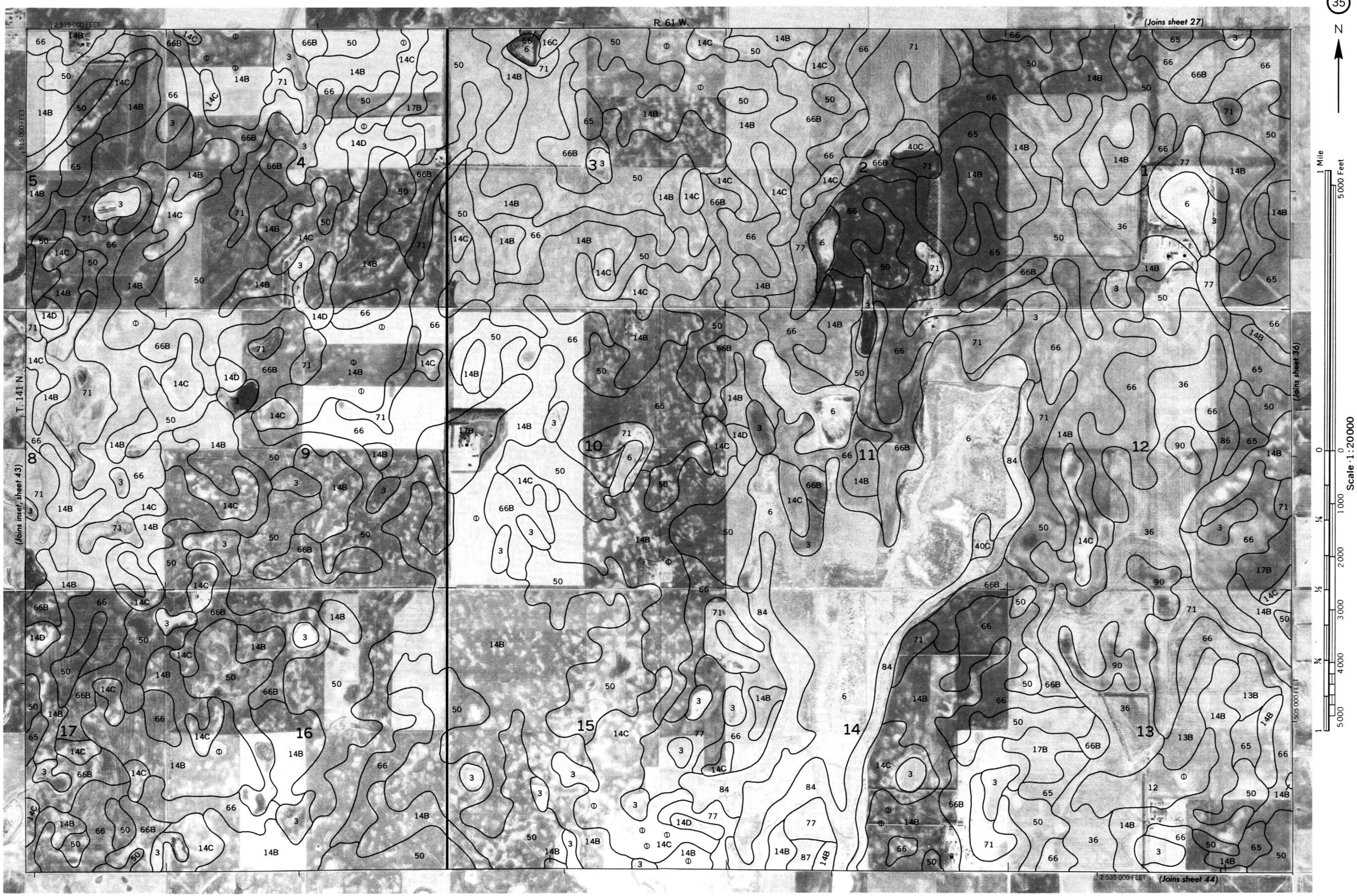
BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 34





This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 34

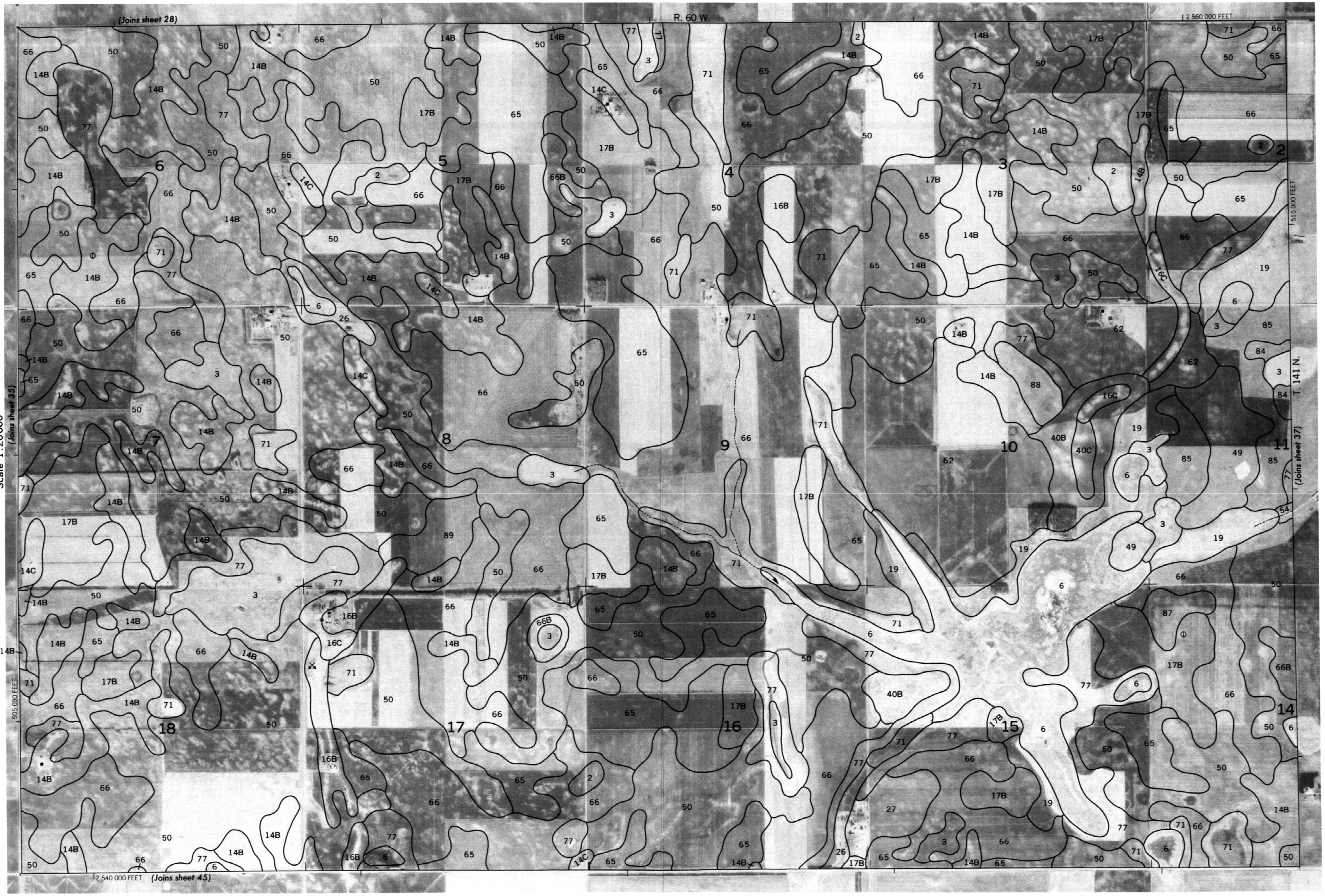


BARNES COUNTY, NORTH DAKOTA NO. 35

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 36

N

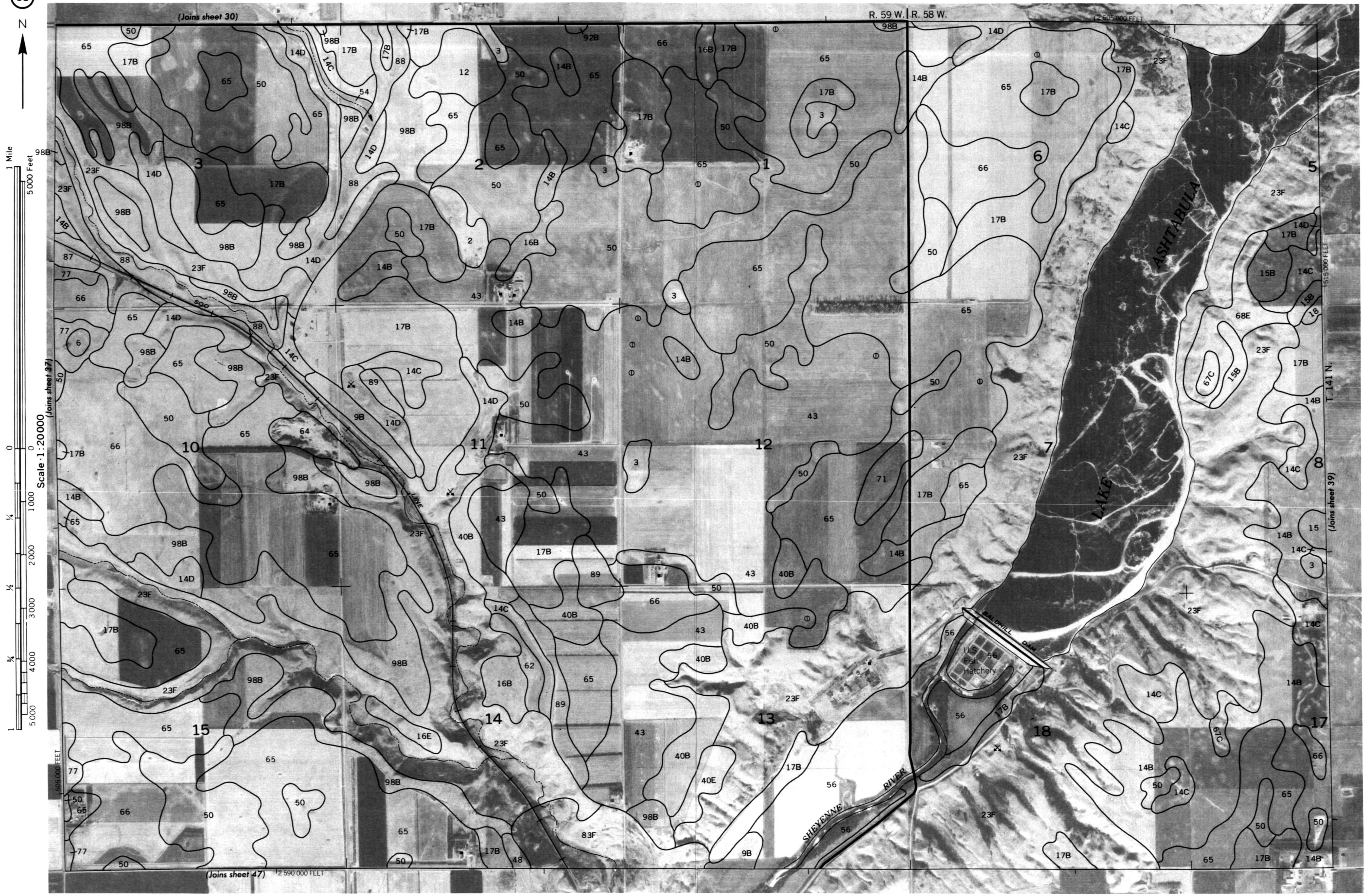


1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000
0 ¼ ½ ¾ 1

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

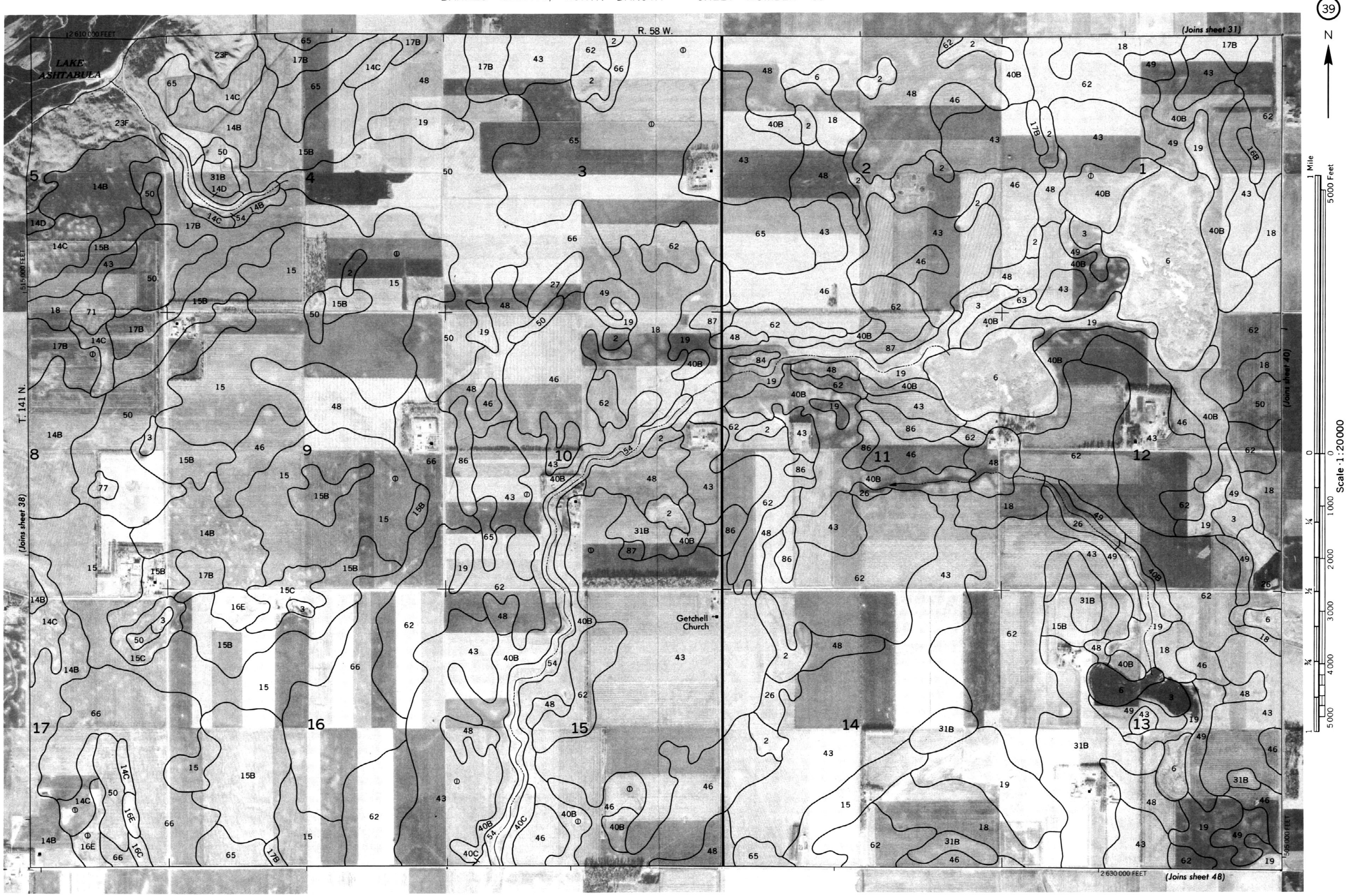
BARNES COUNTY, NORTH DAKOTA NO. 37

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

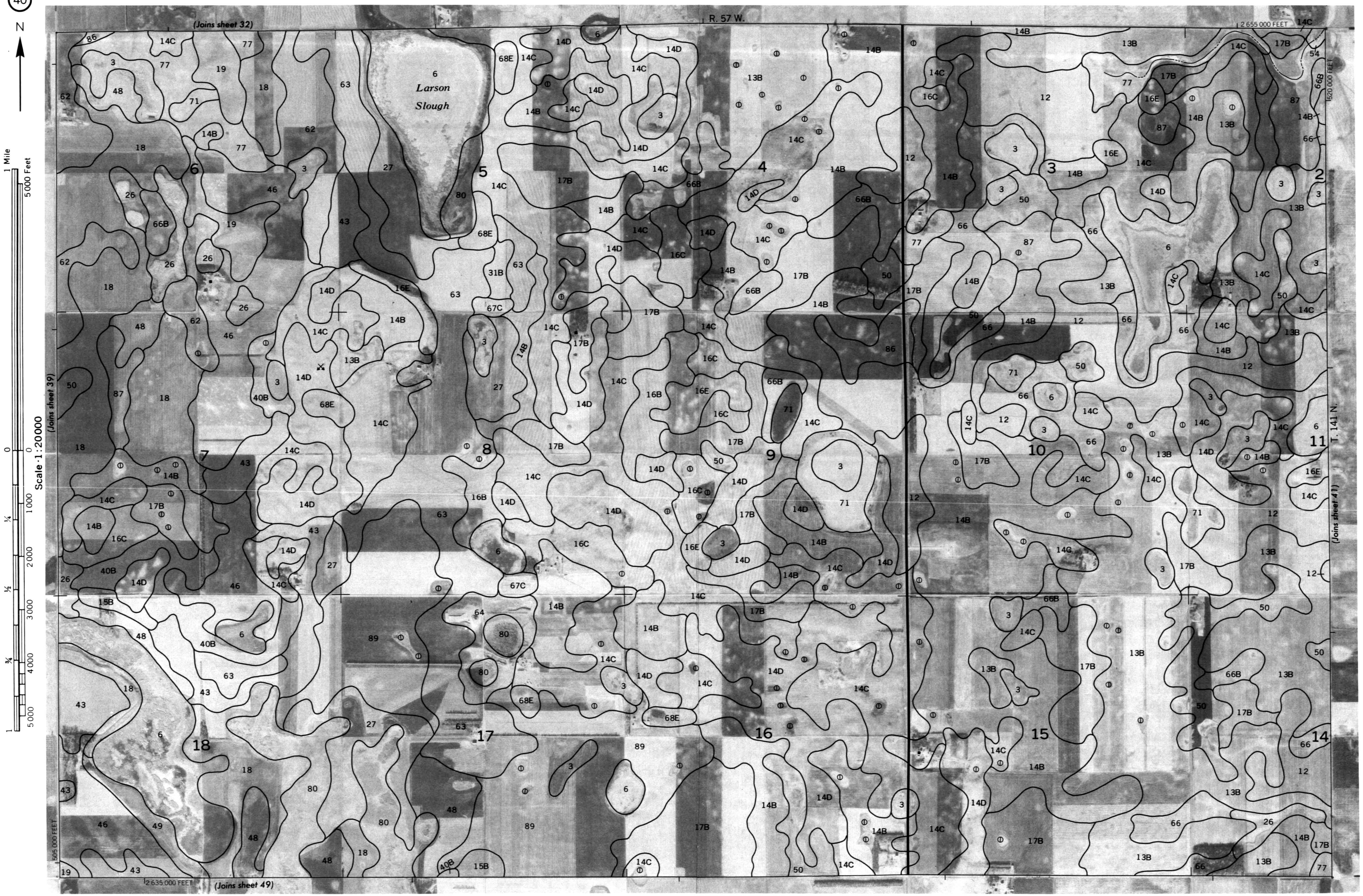
BARNES COUNTY, NORTH DAKOTA NO. 38



BARNES COUNTY, NORTH DAKOTA NO. 39

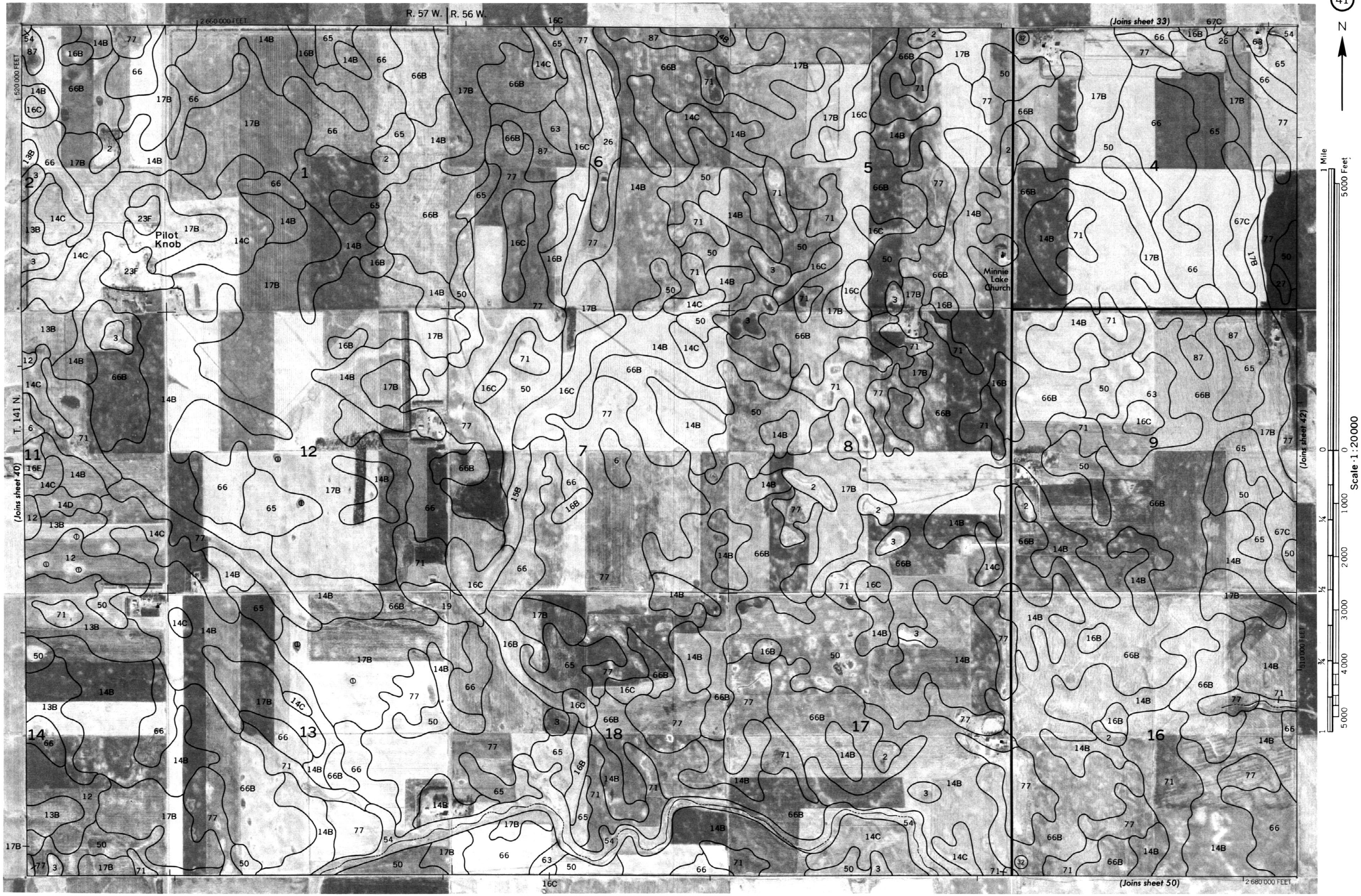
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 40



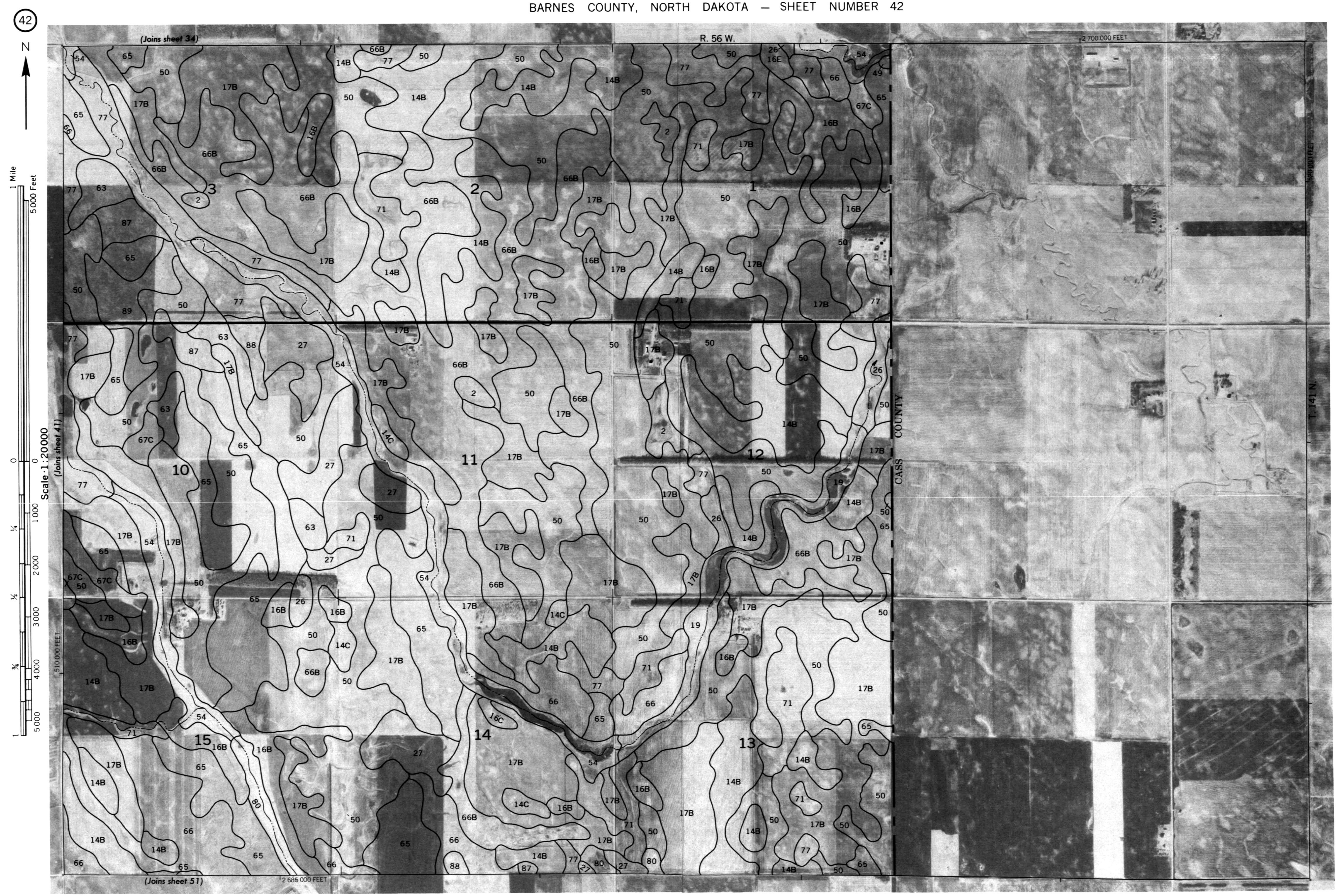
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 40



BARNES COUNTY, NORTH DAKOTA NO. 41

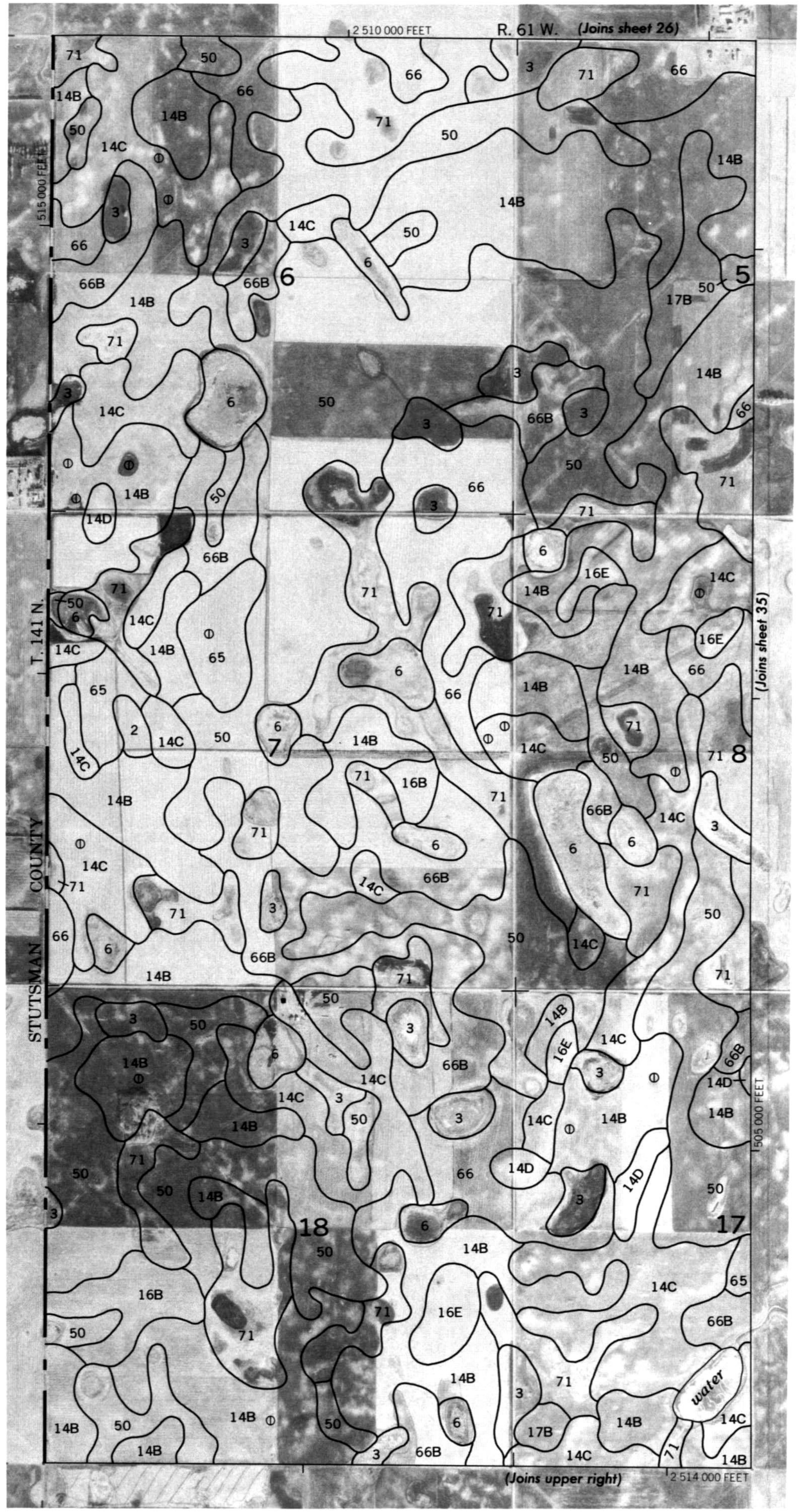
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



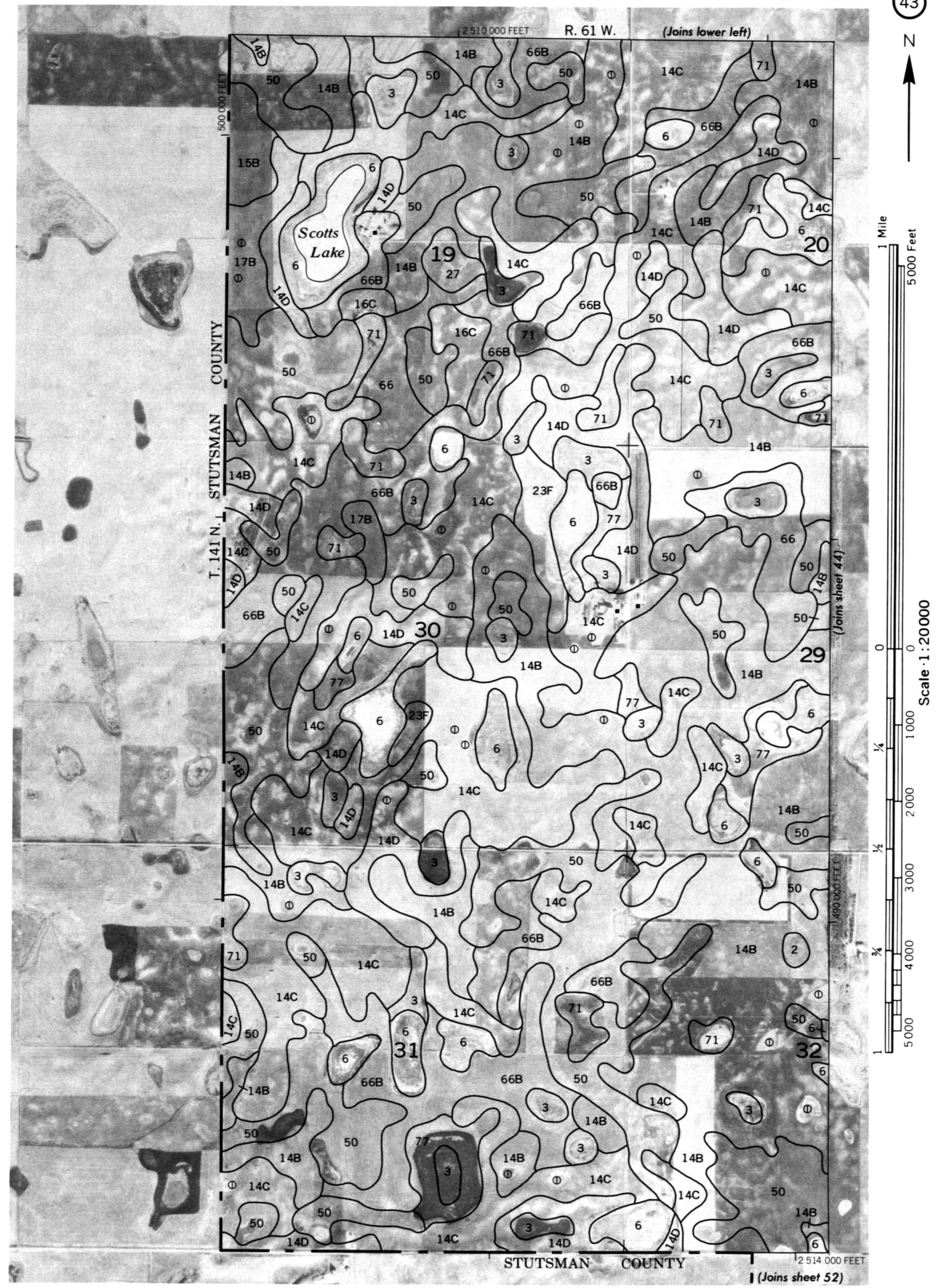
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 43

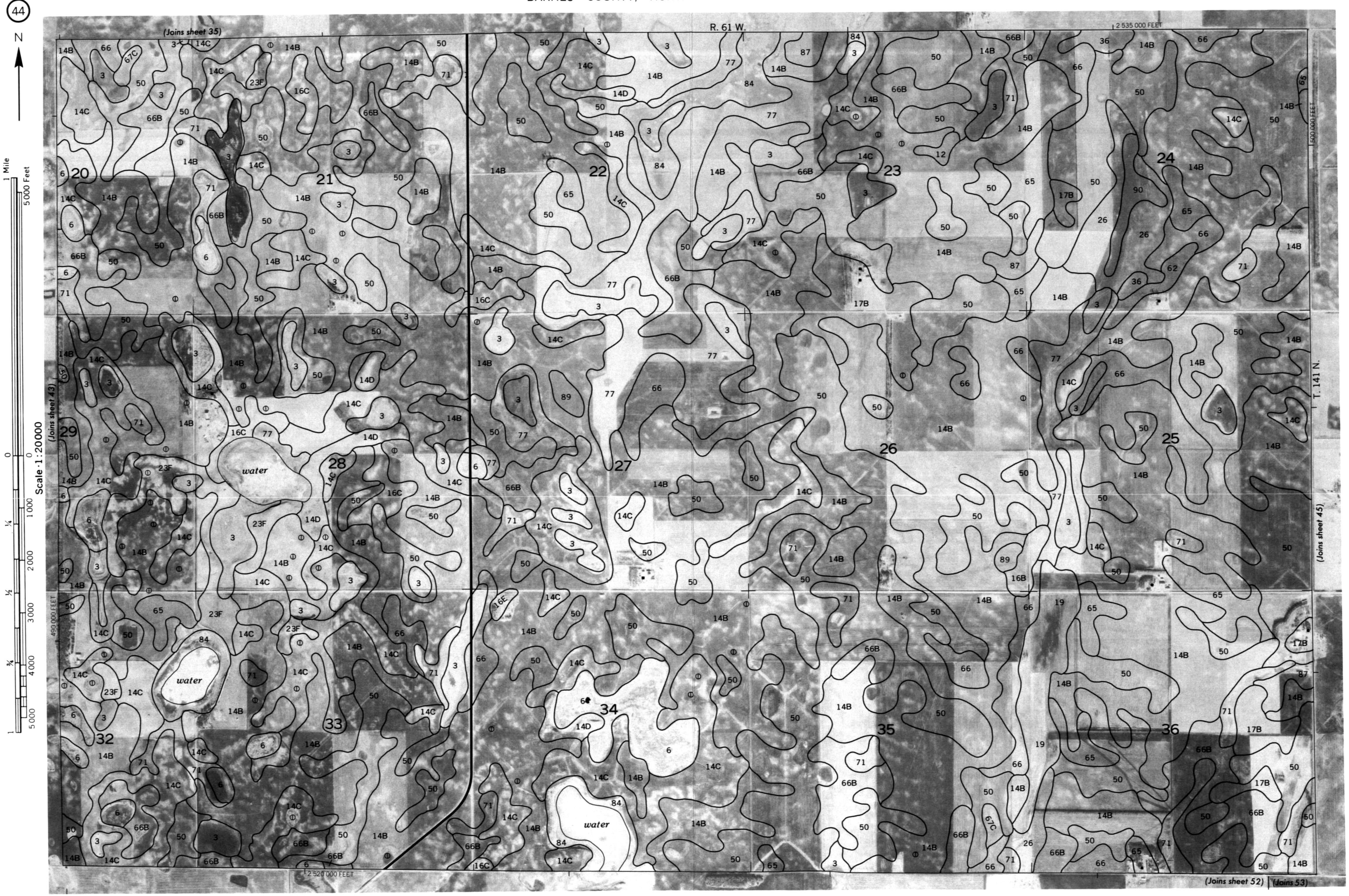
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



4000 AND 5000-FOOT GRID TICKS



4000 AND 5000-FOOT GRID TICKS

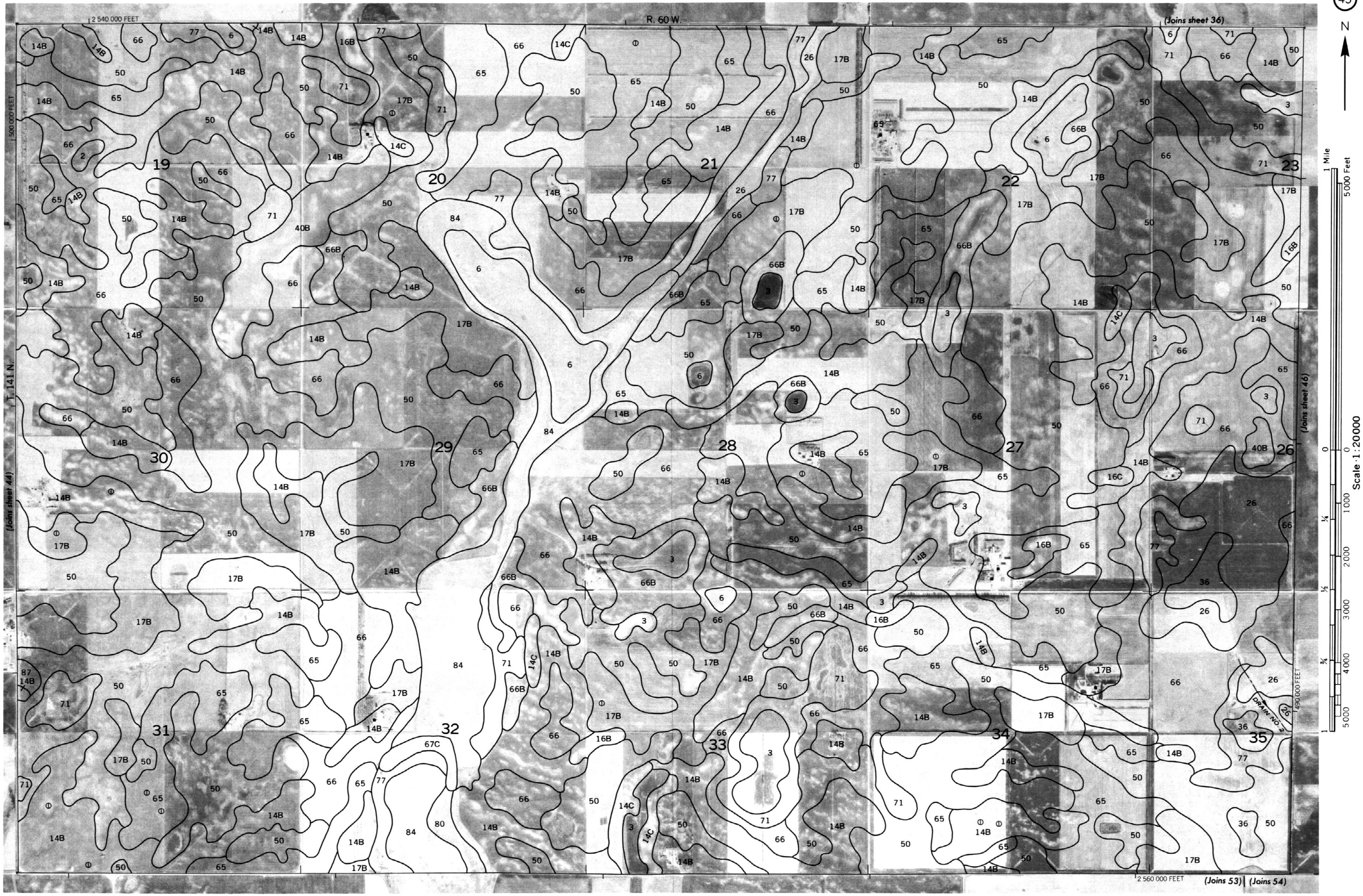


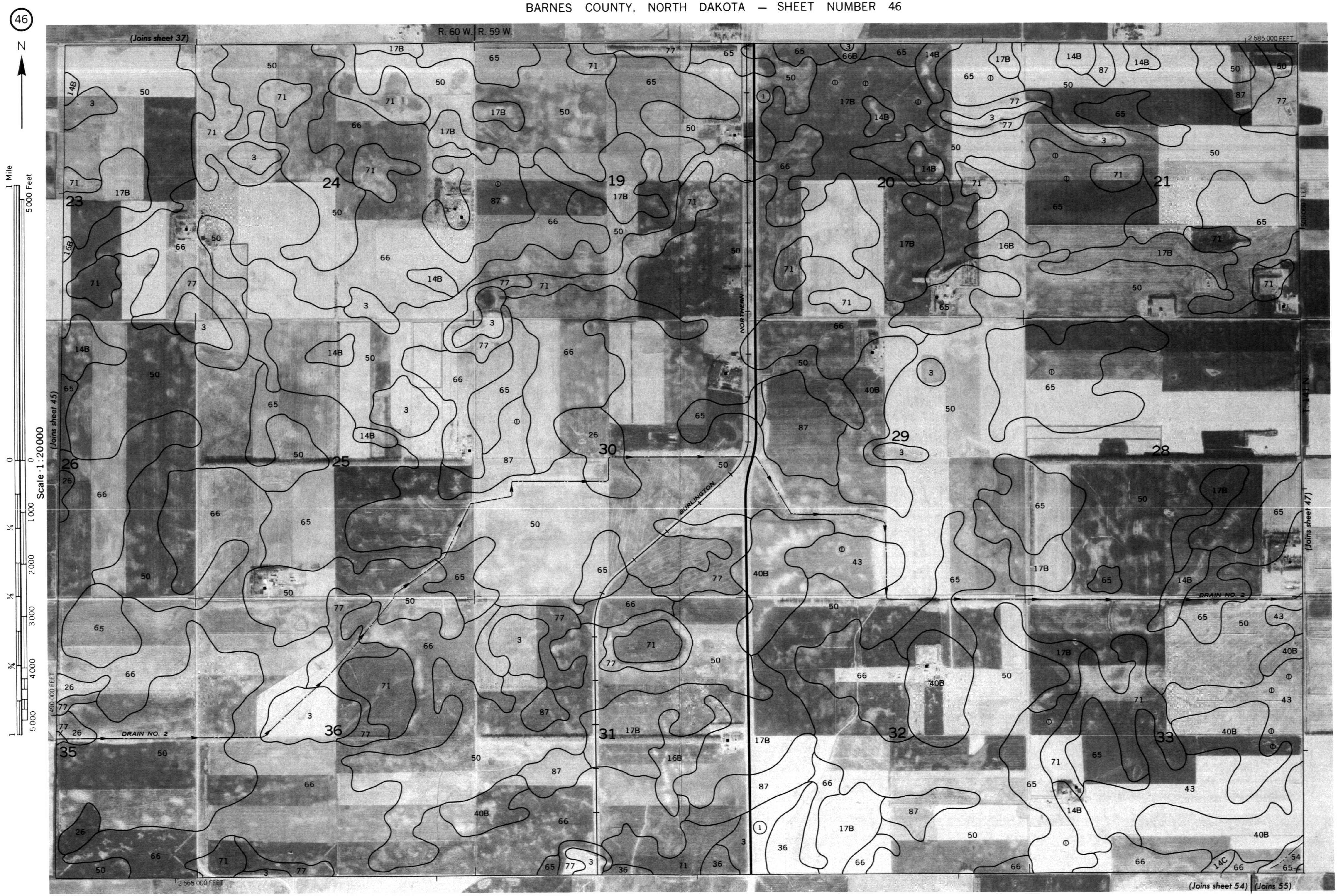
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 44

BARNES COUNTY, NORTH DAKOTA NO. 45

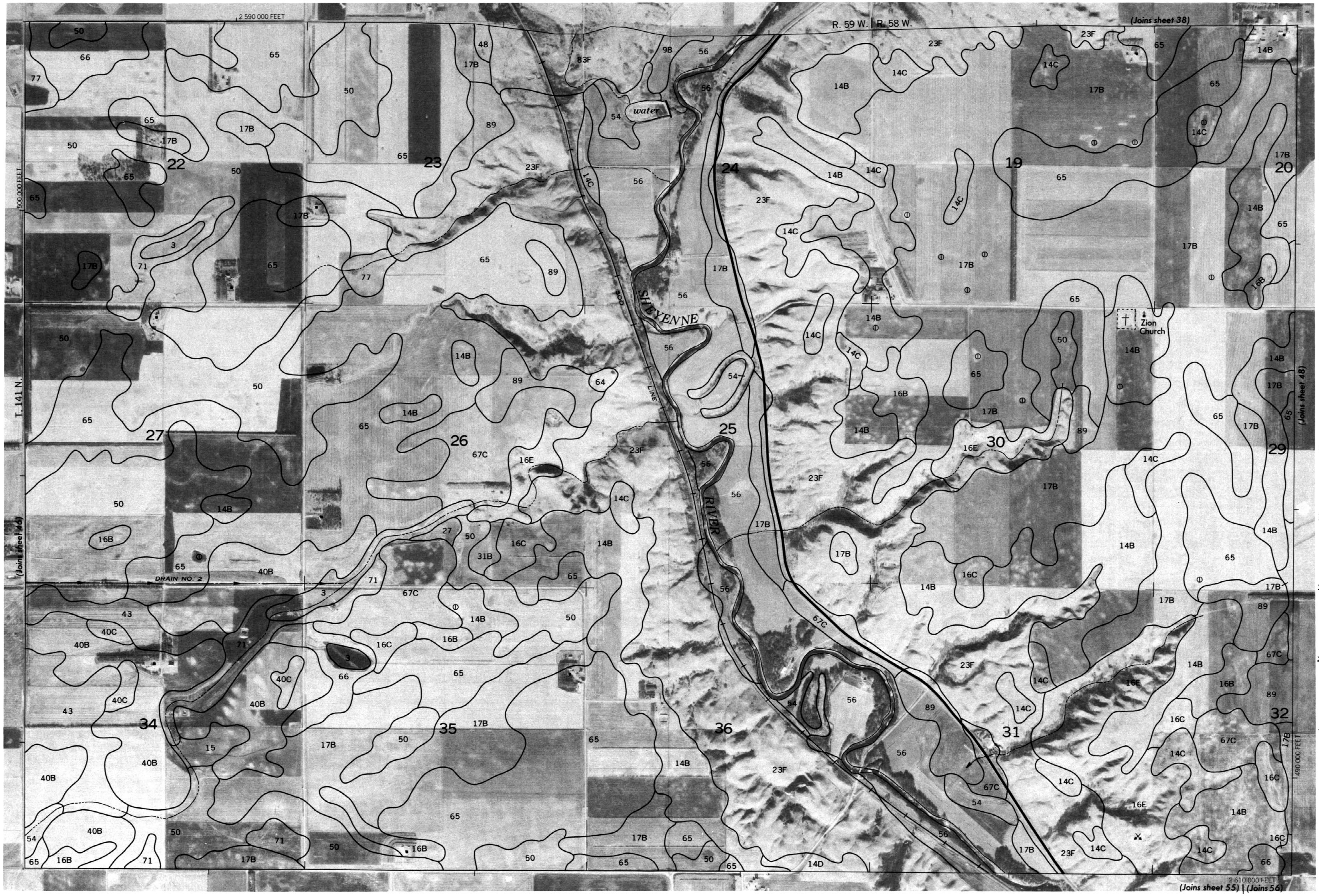
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

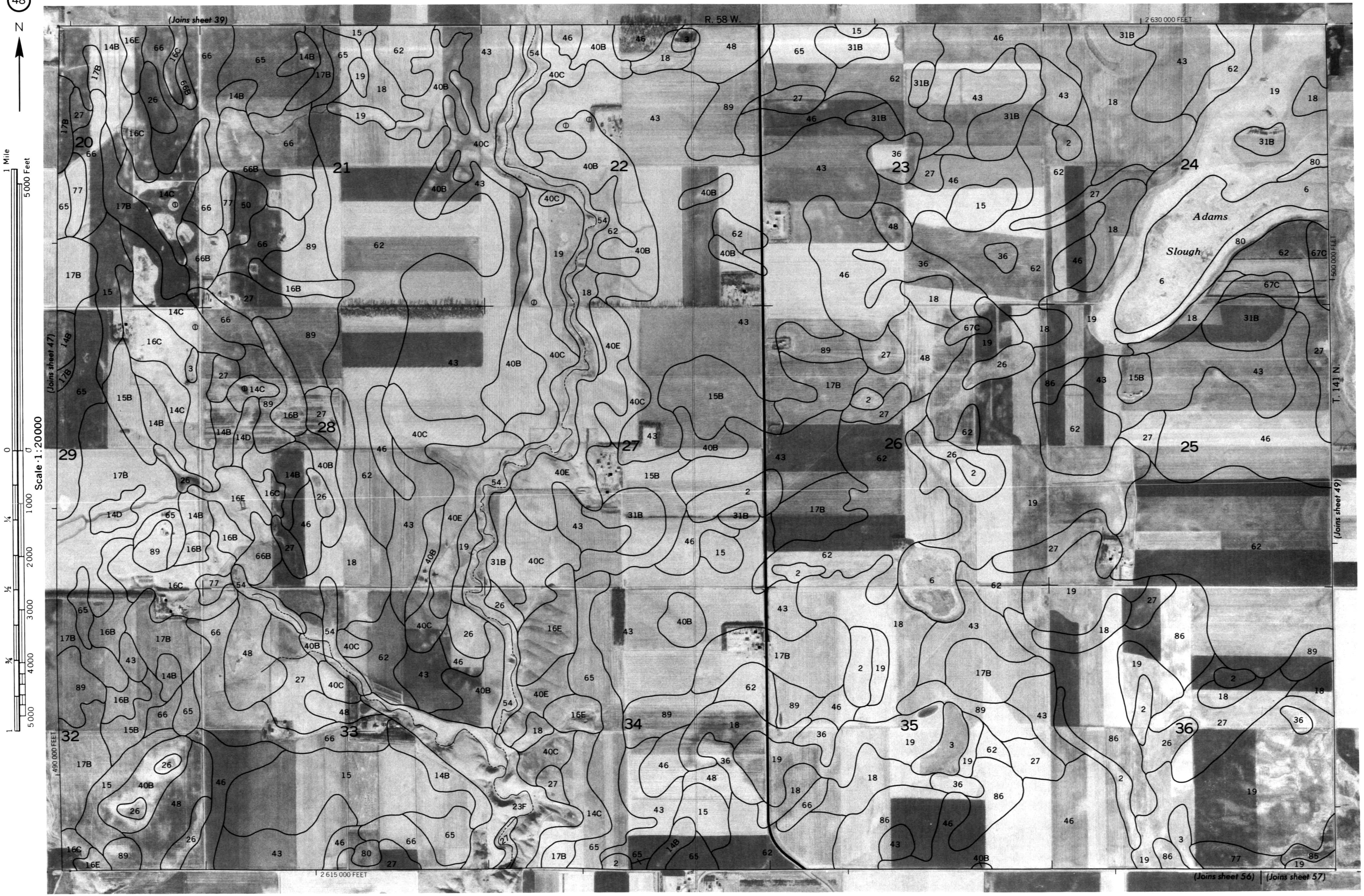
BARNES COUNTY, NORTH DAKOTA NO. 46



BARNES COUNTY, NORTH DAKOTA NO. 47

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

48

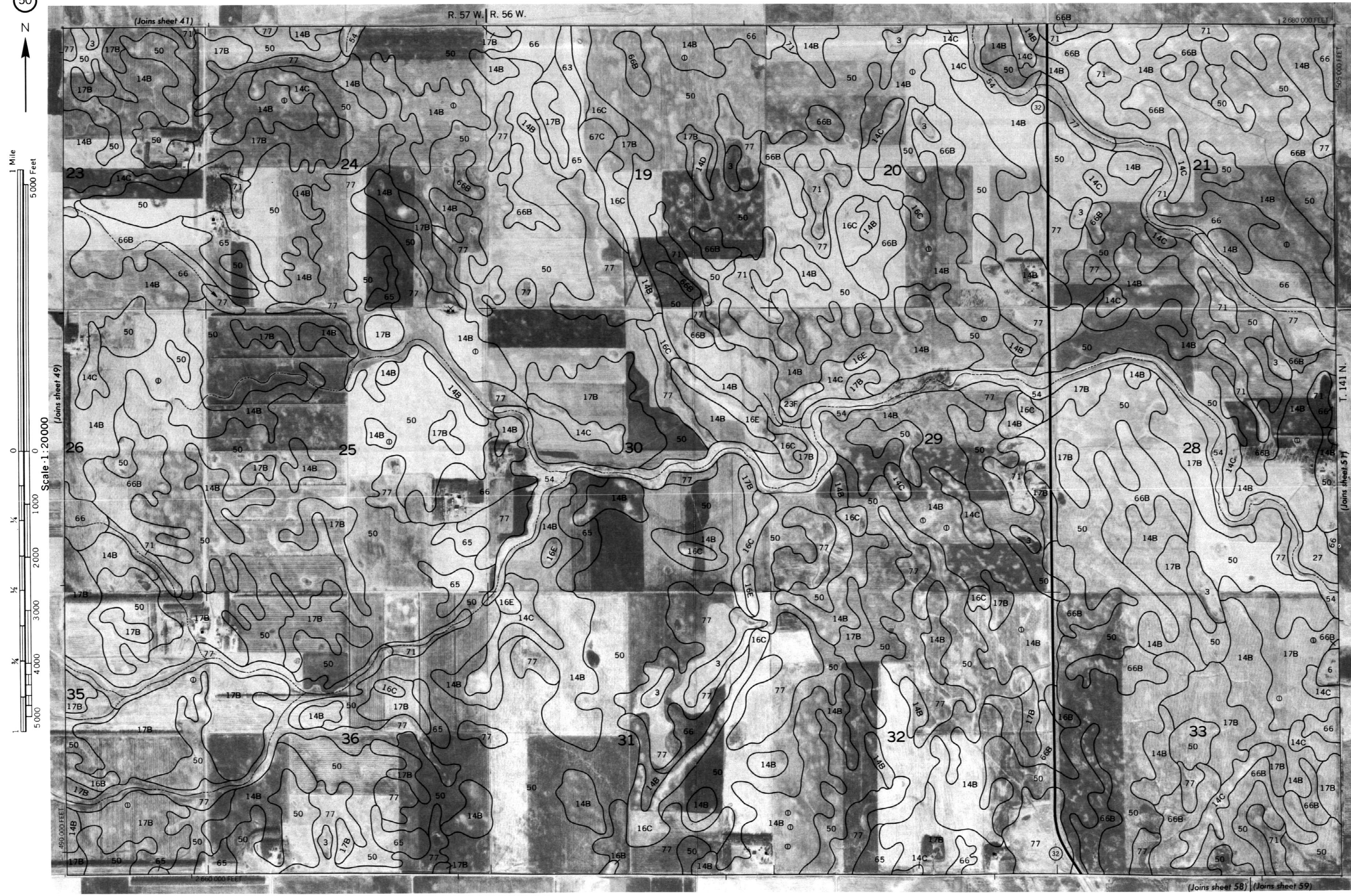


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 48

BARNES COUNTY, NORTH DAKOTA NO. 49

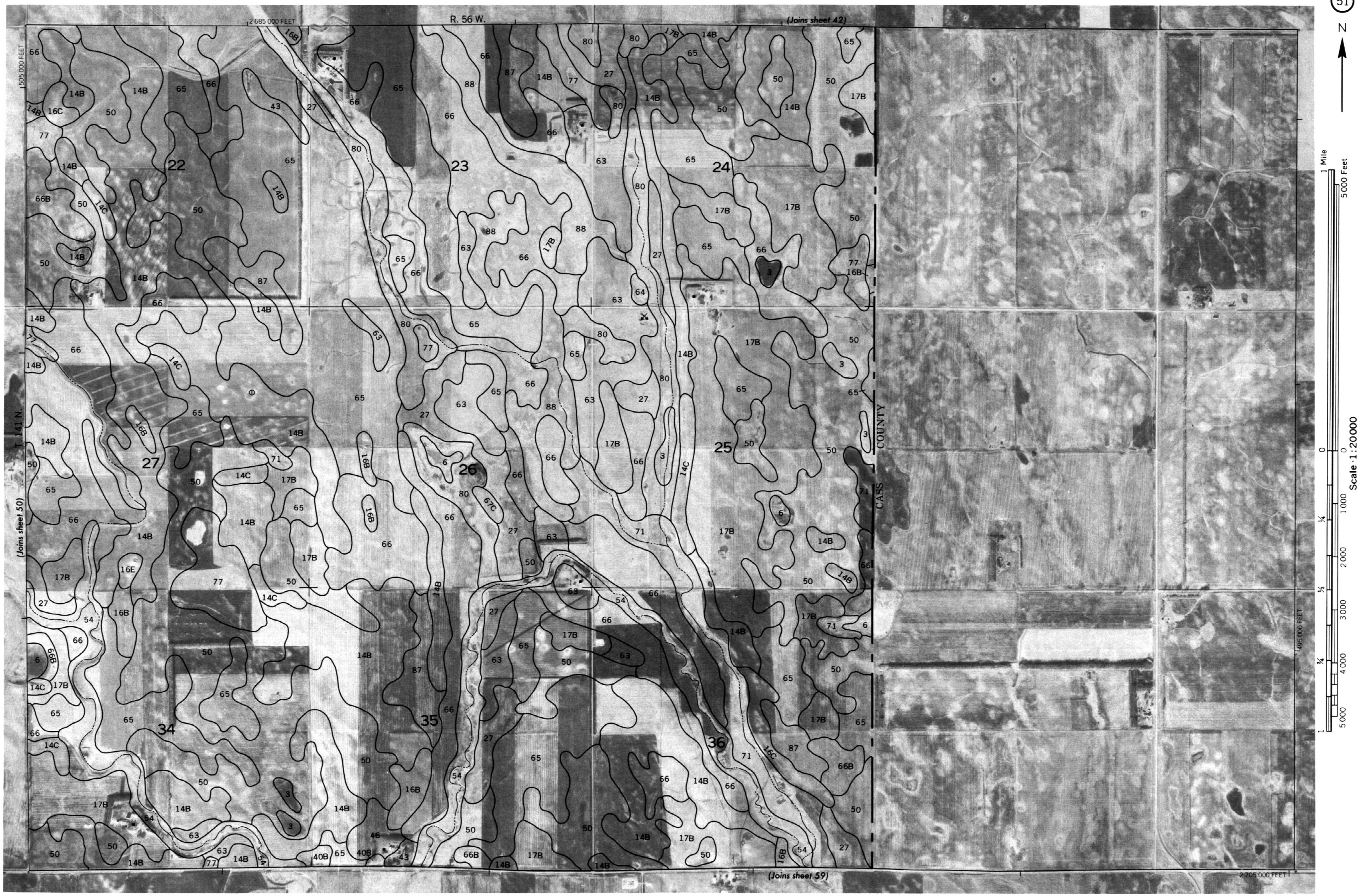
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

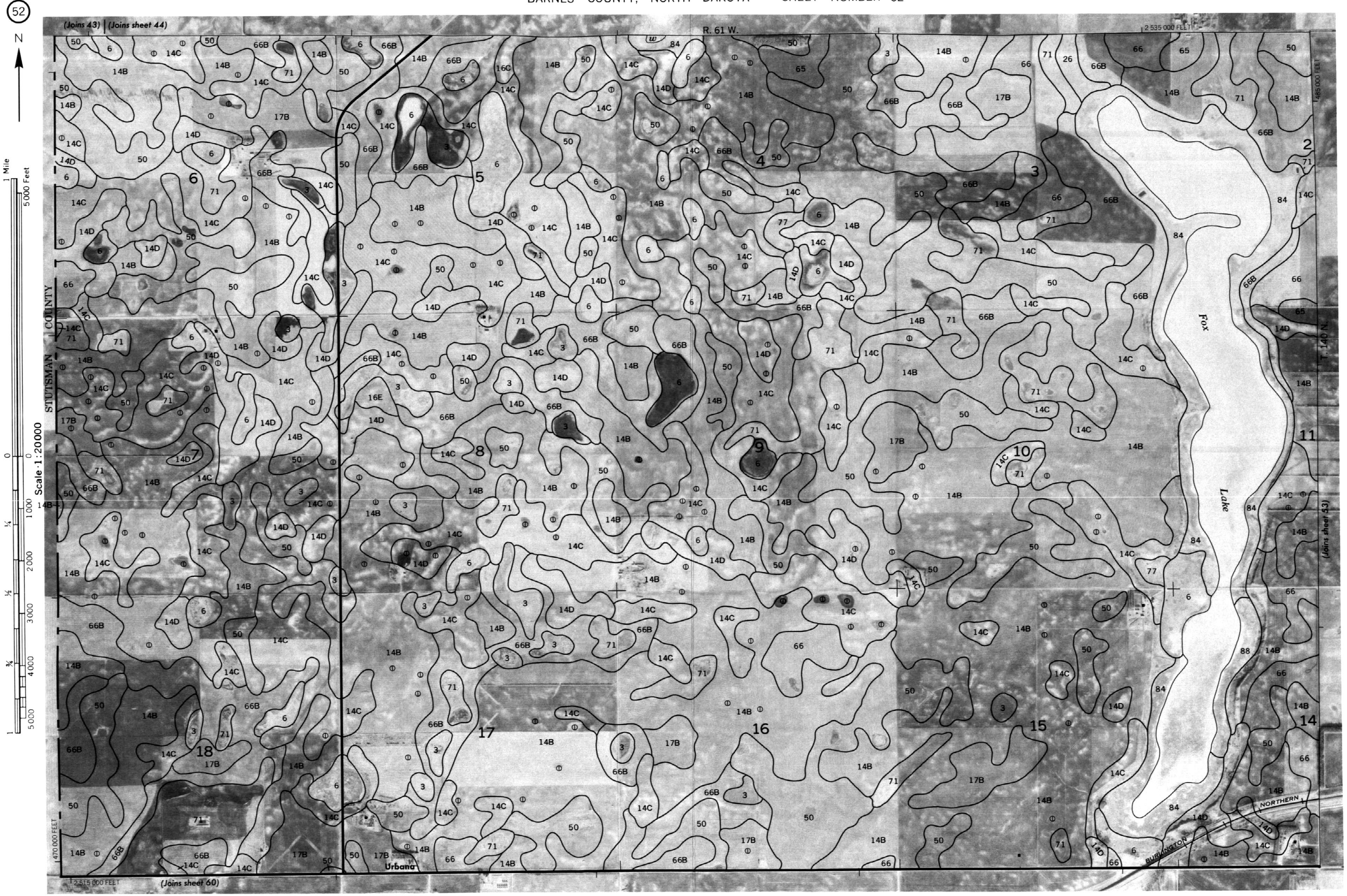


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

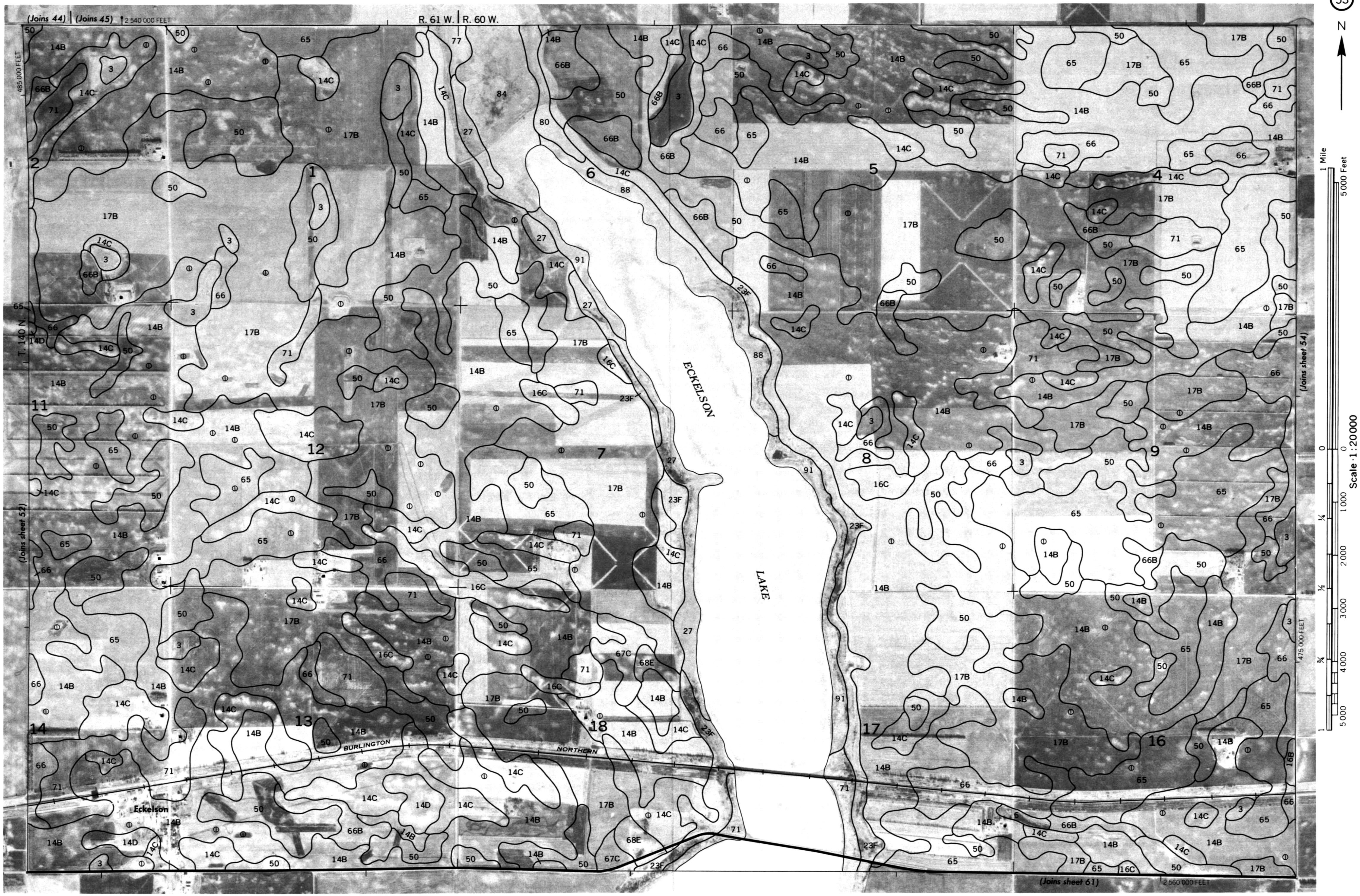
BARNES COUNTY, NORTH DAKOTA NO. 51

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



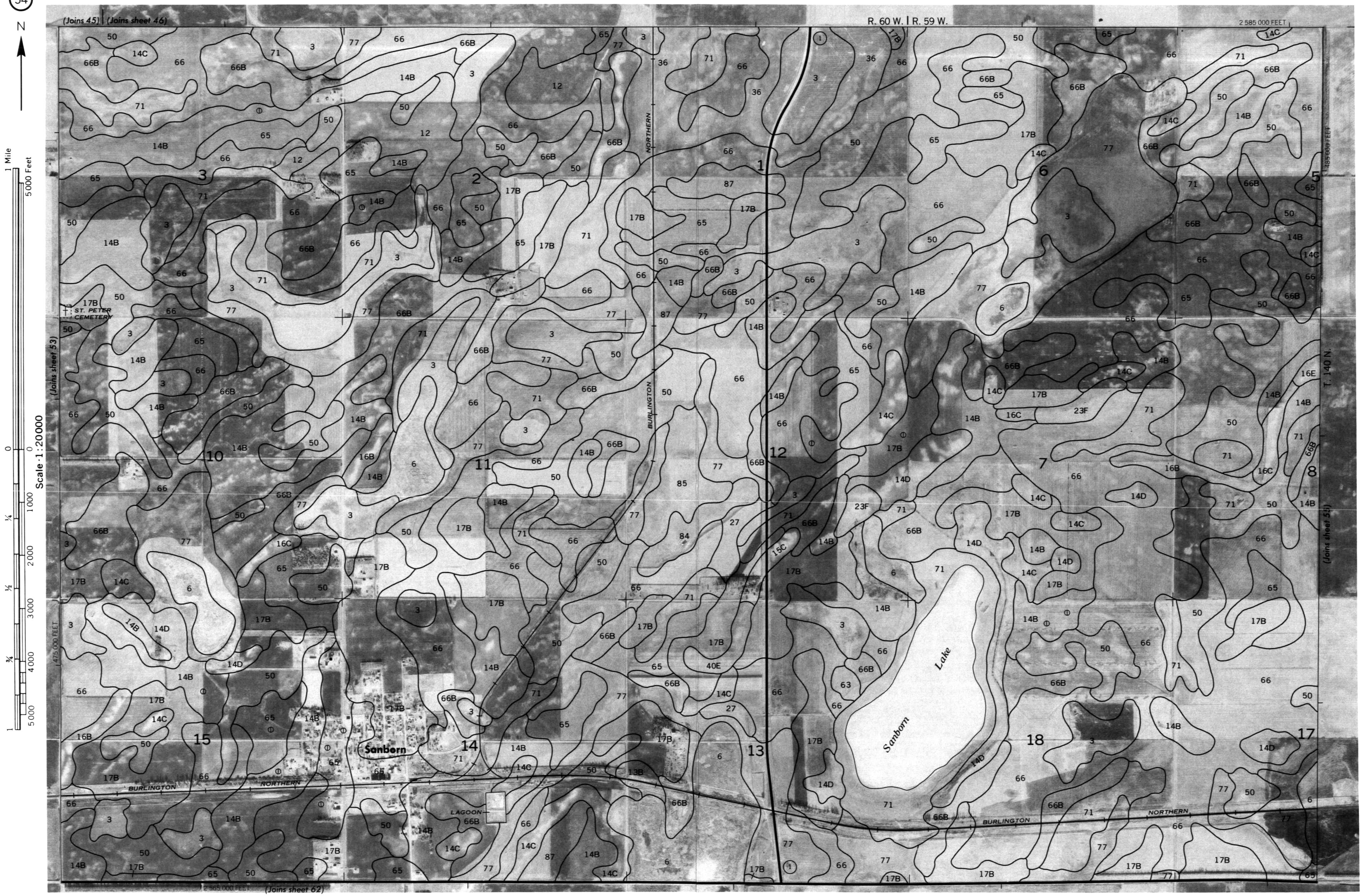


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



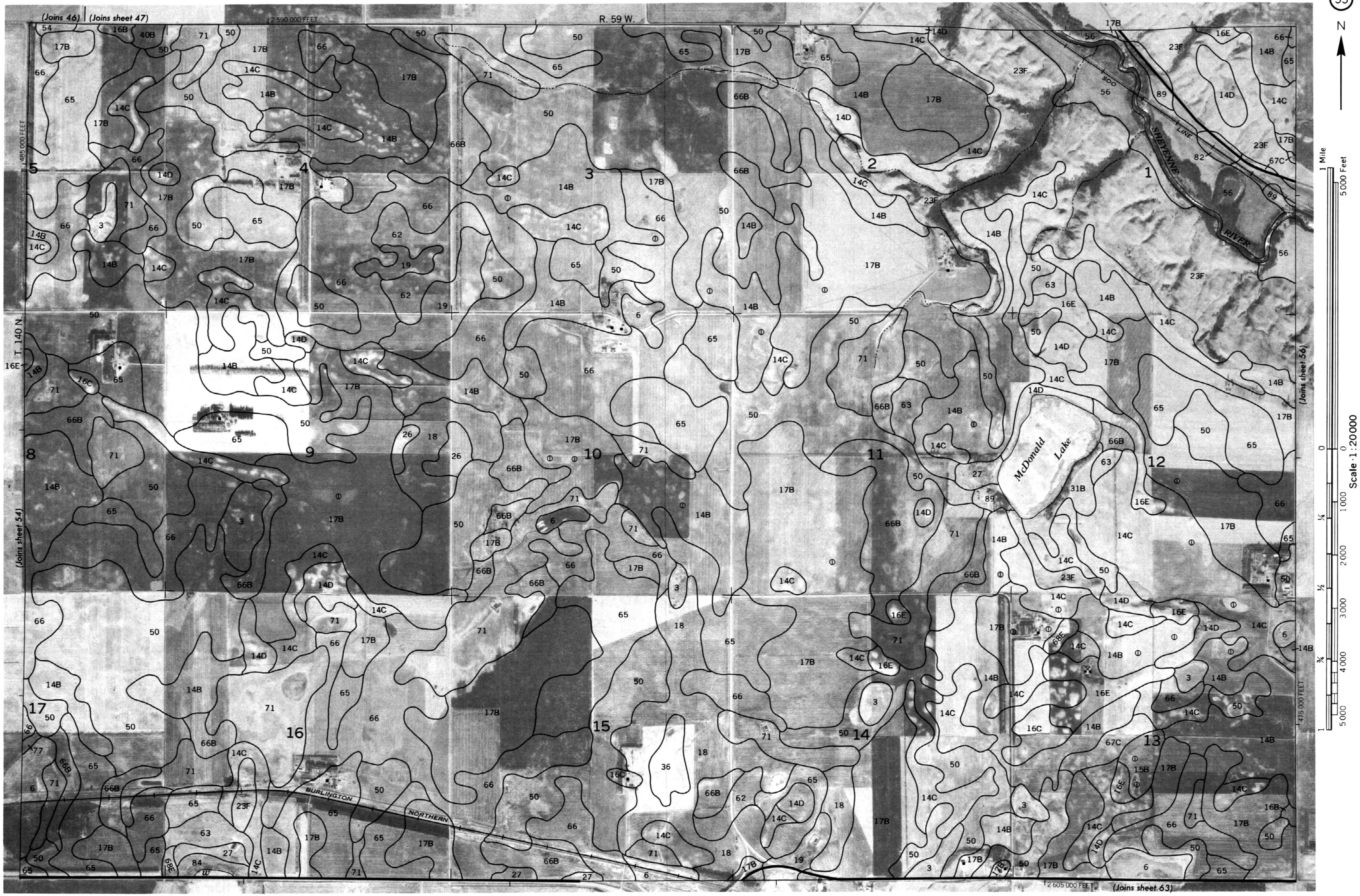
BARNES COUNTY, NORTH DAKOTA NO. 53

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



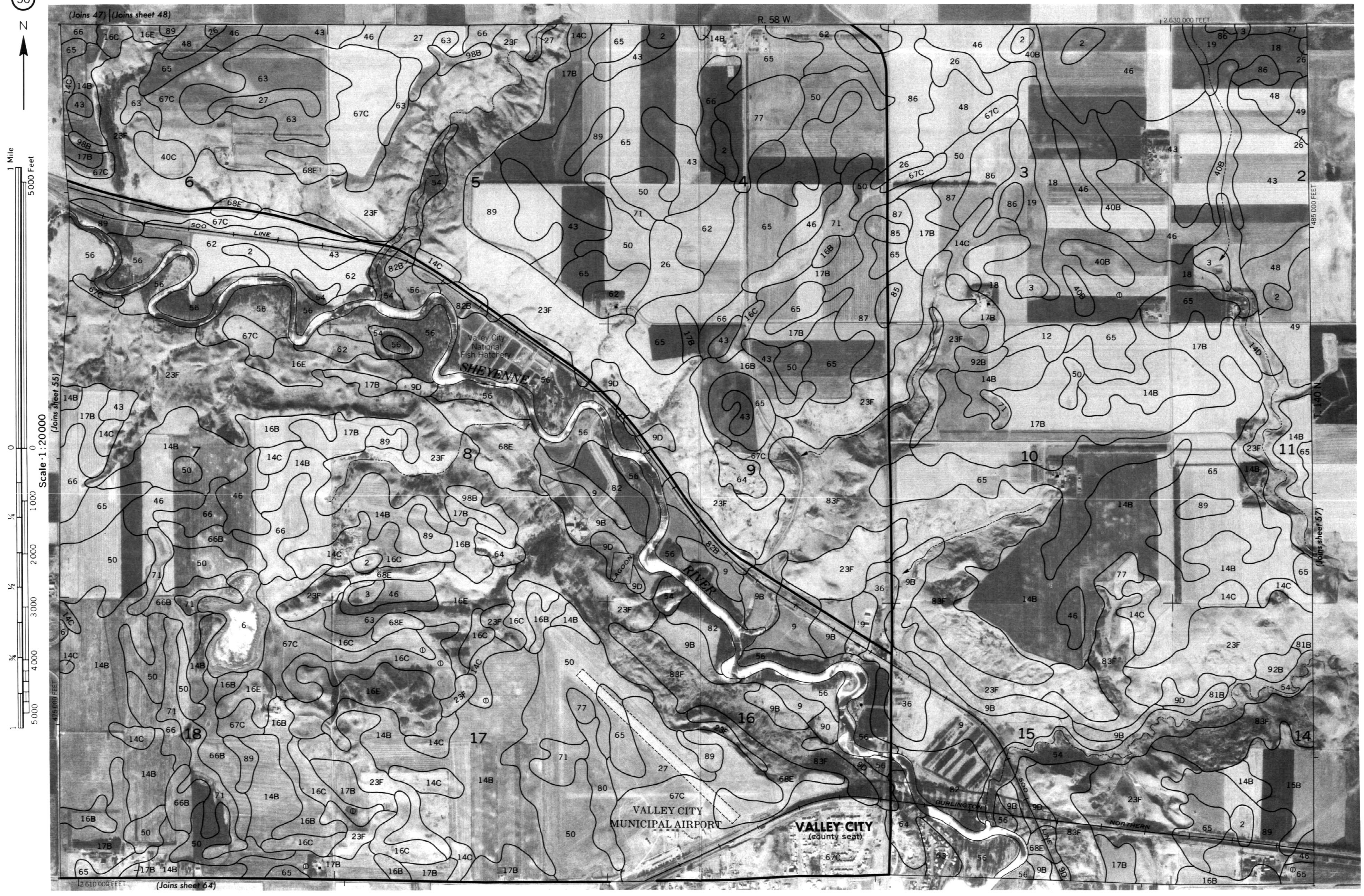
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 54



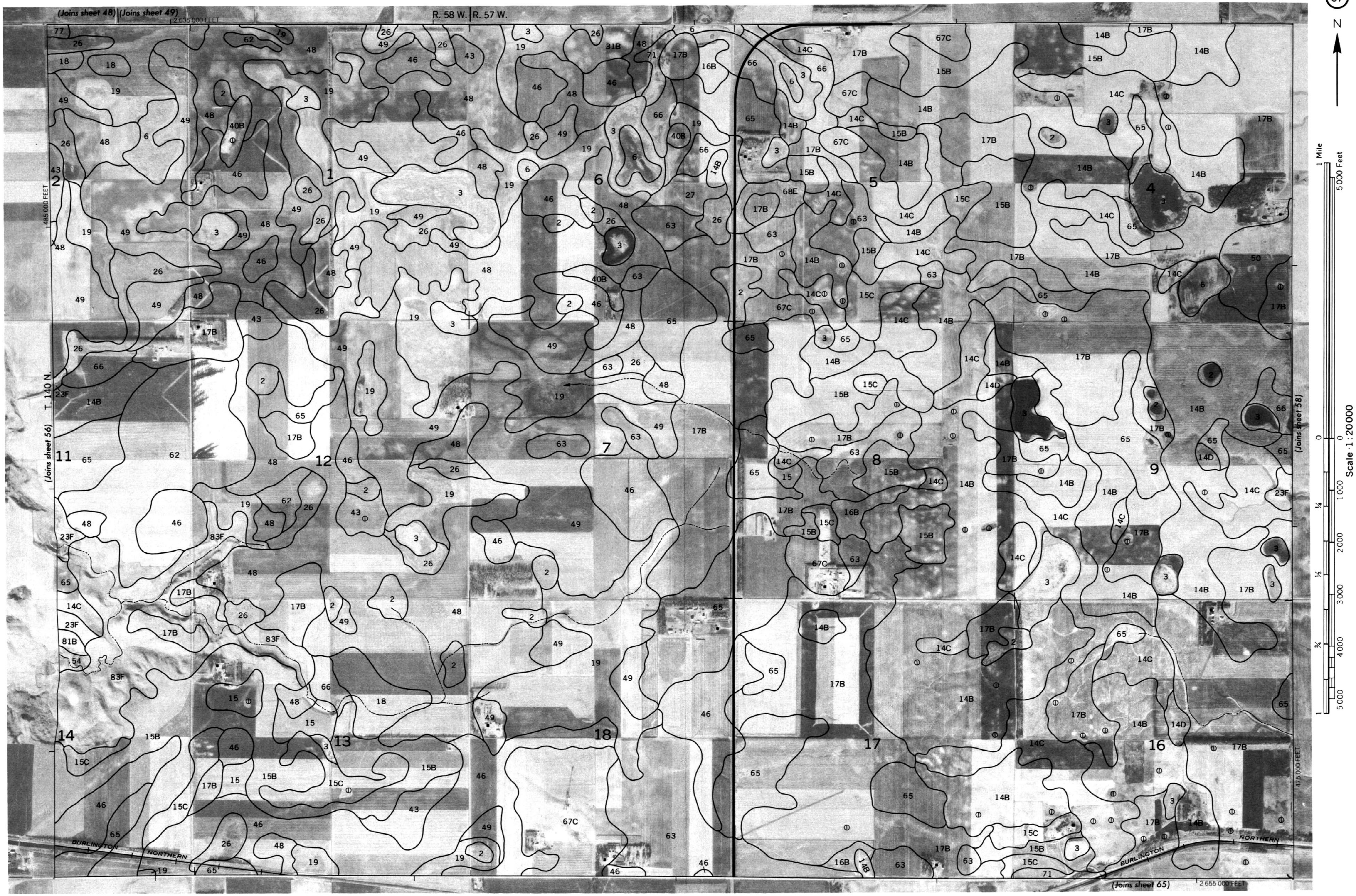
BARNES COUNTY, NORTH DAKOTA NO. 55

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

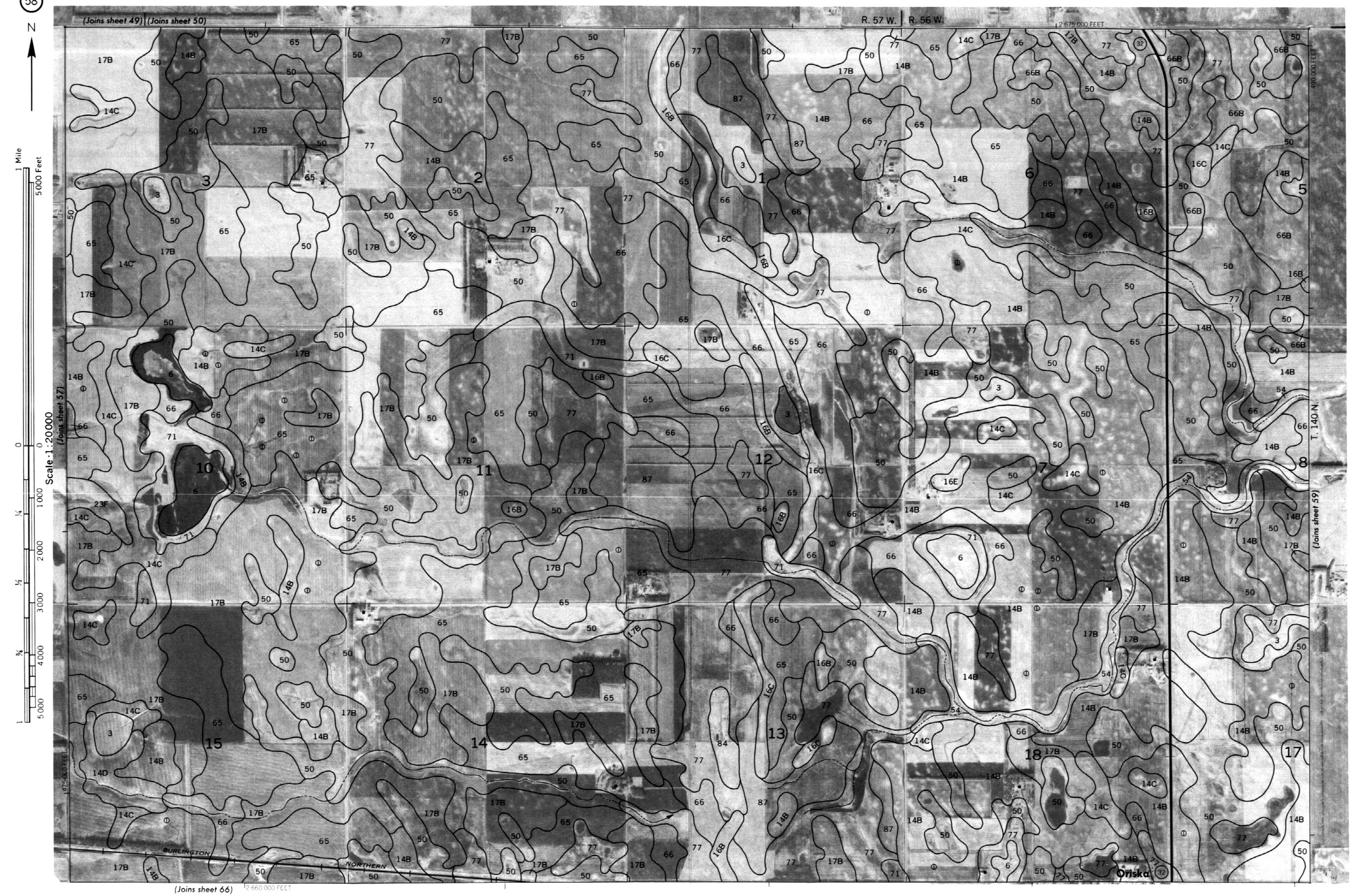
BARNES COUNTY, NORTH DAKOTA NO. 56



BARNES COUNTY, NORTH DAKOTA NO. 57

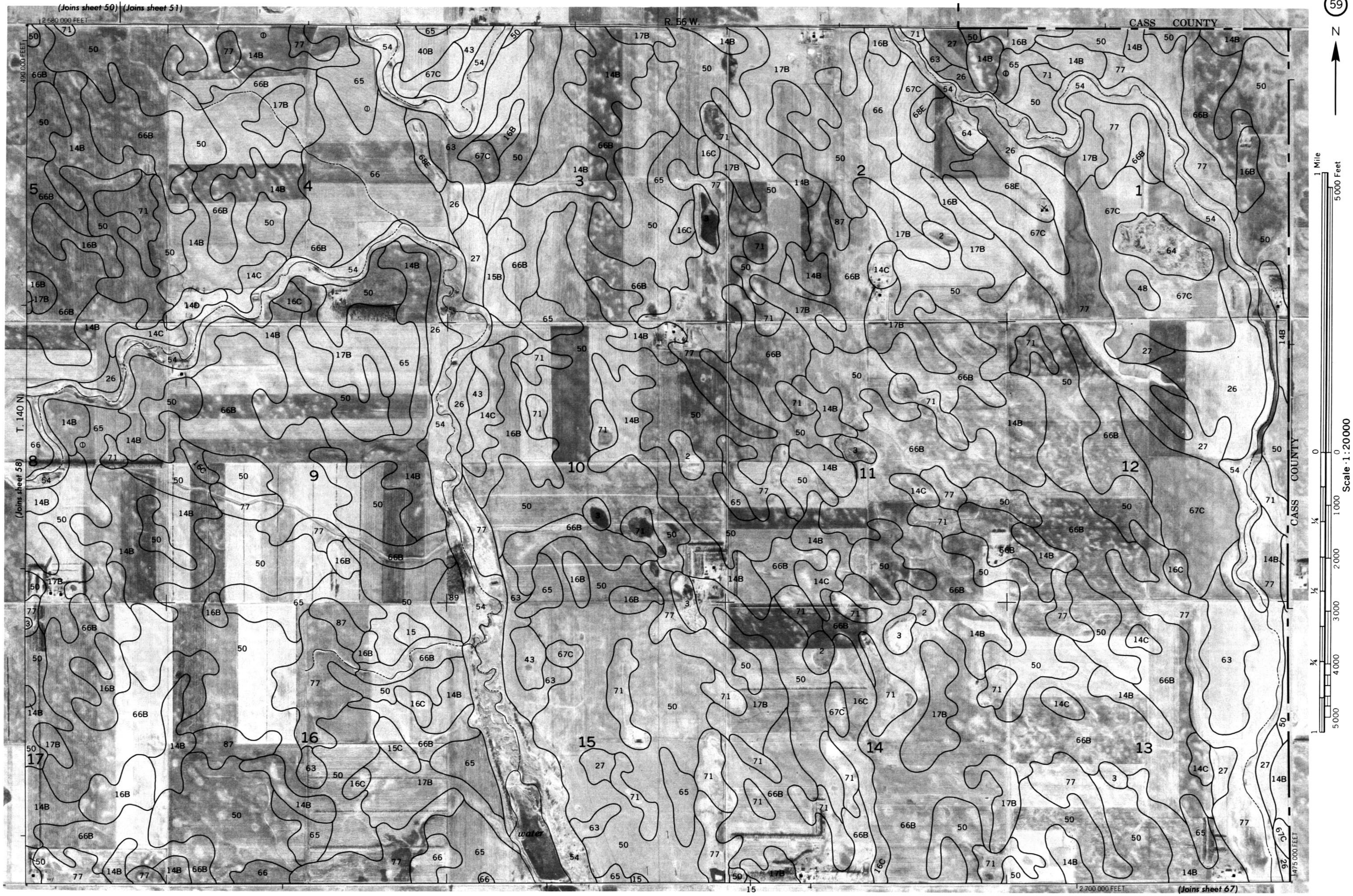
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 58



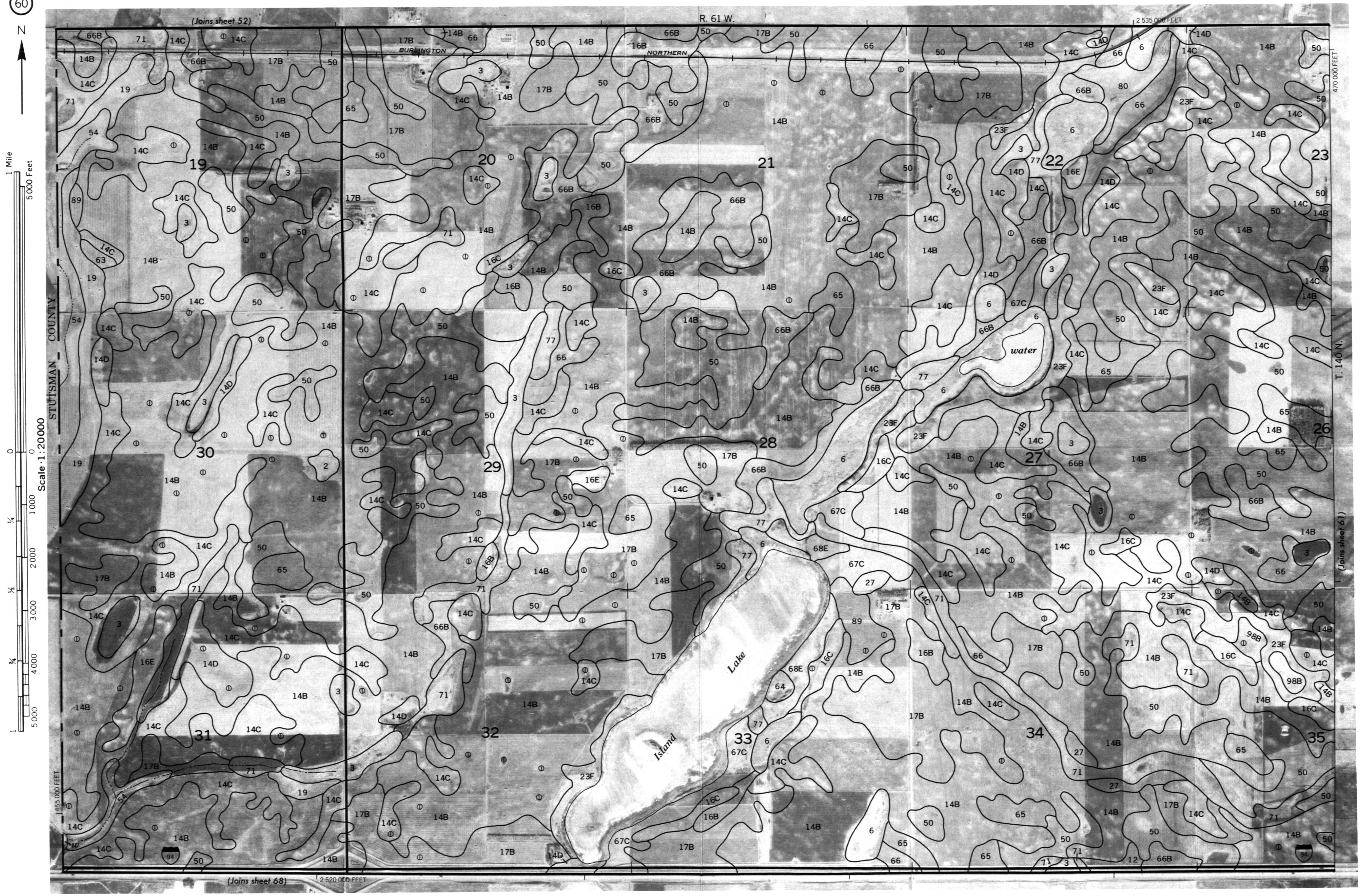
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 58



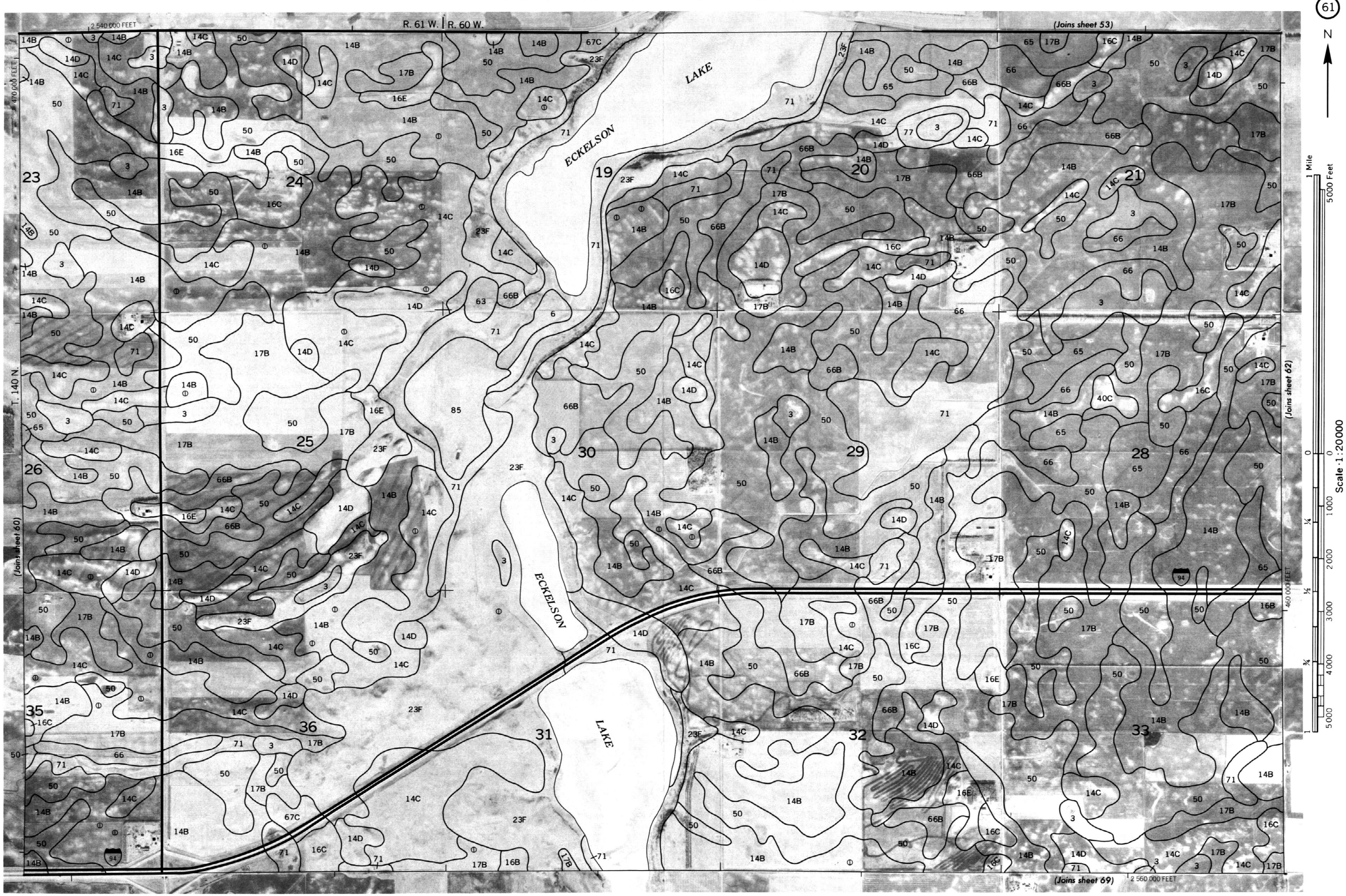
BARNES COUNTY, NORTH DAKOTA NO. 59

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



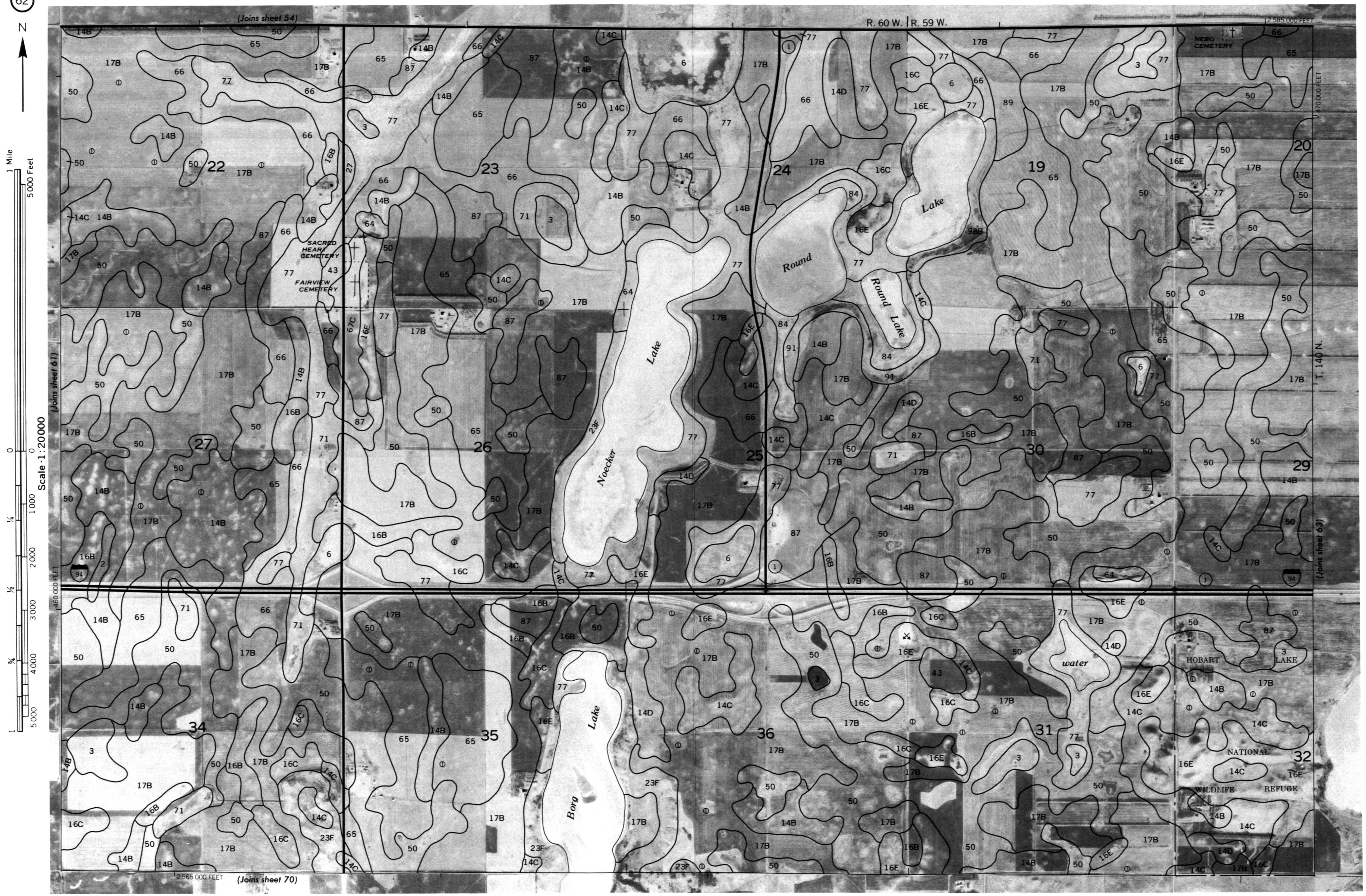
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 60



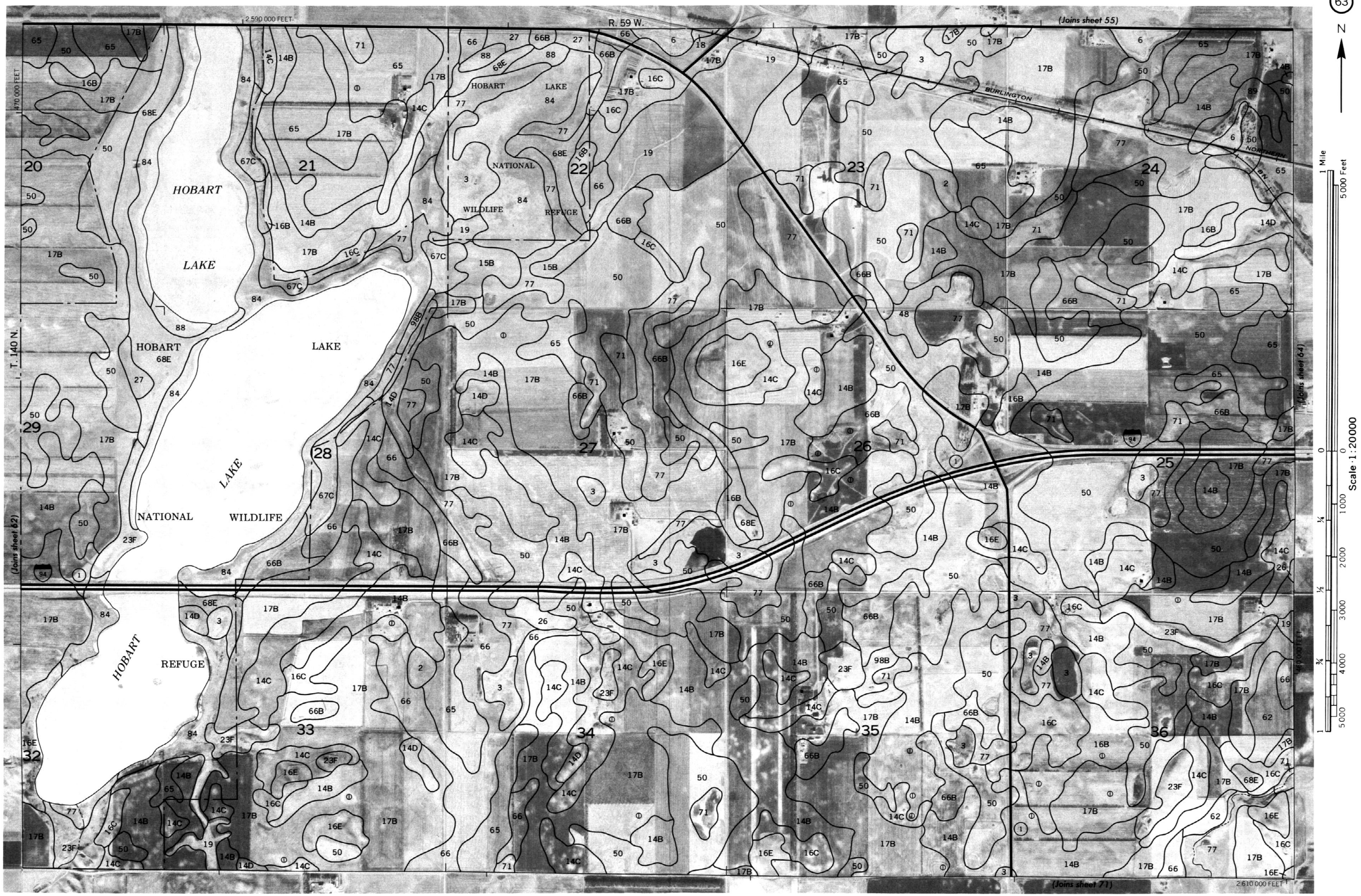
BARNES COUNTY, NORTH DAKOTA NO. 61

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



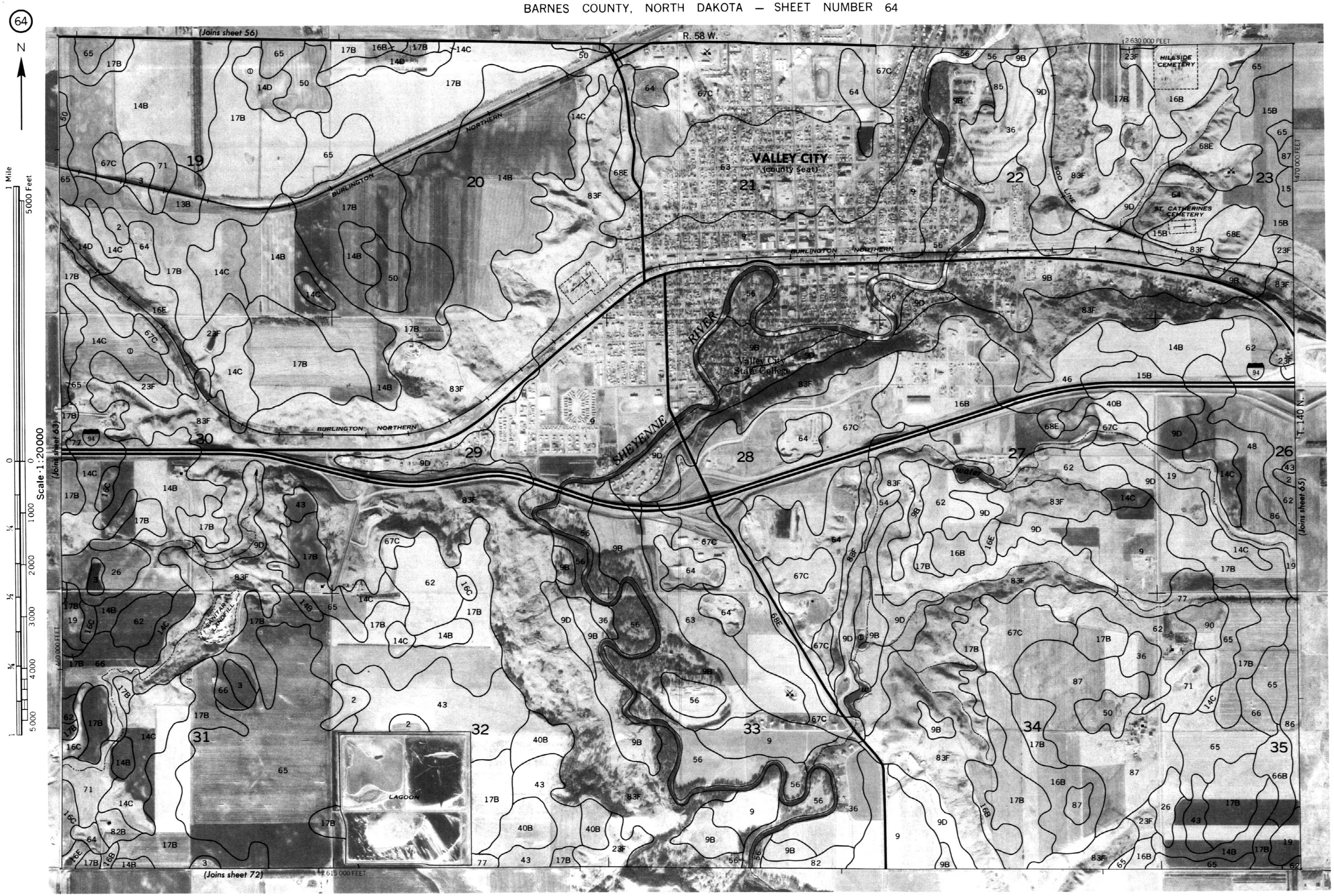
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 62

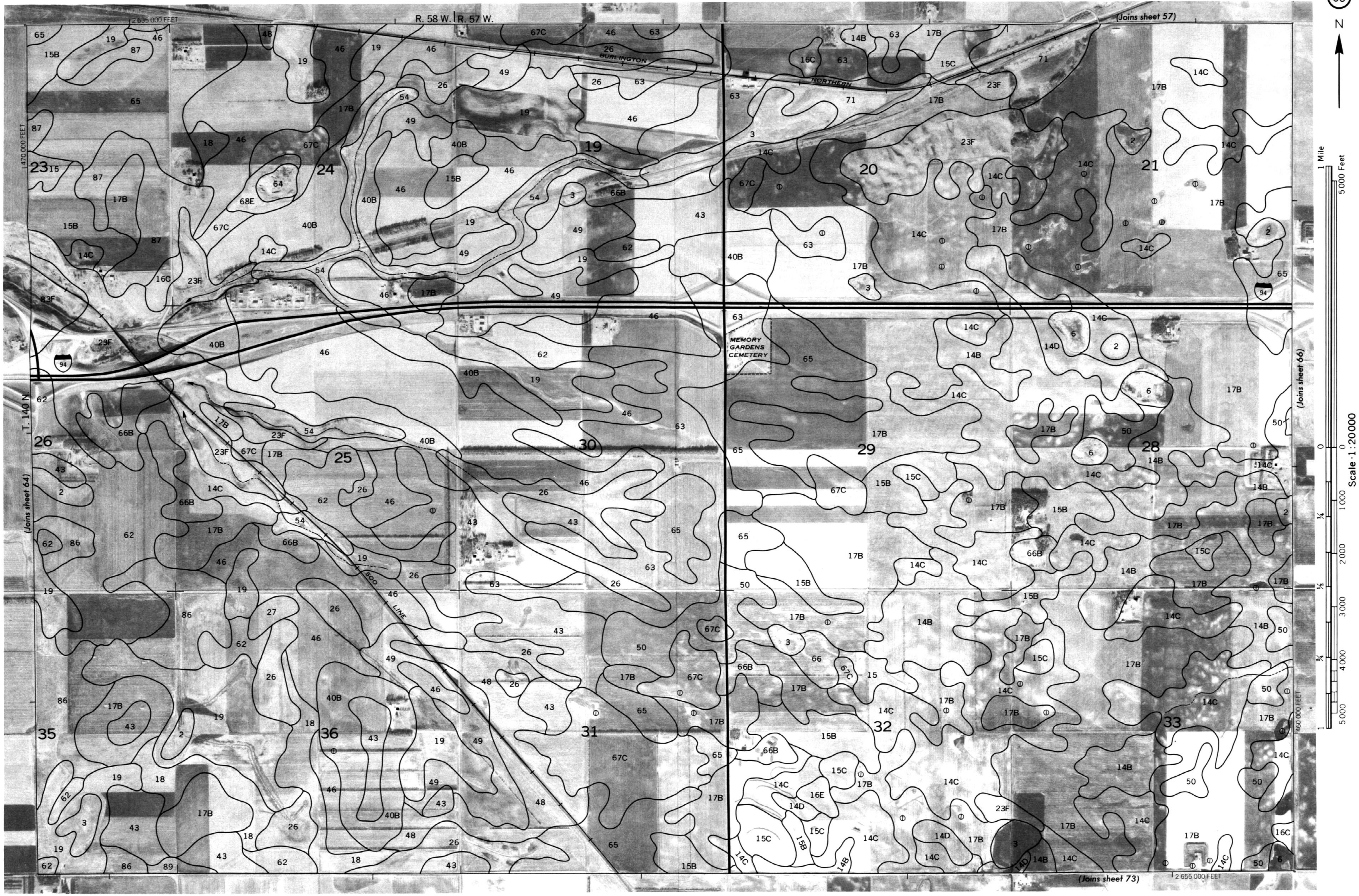


BARNES COUNTY, NORTH DAKOTA NO. 63

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

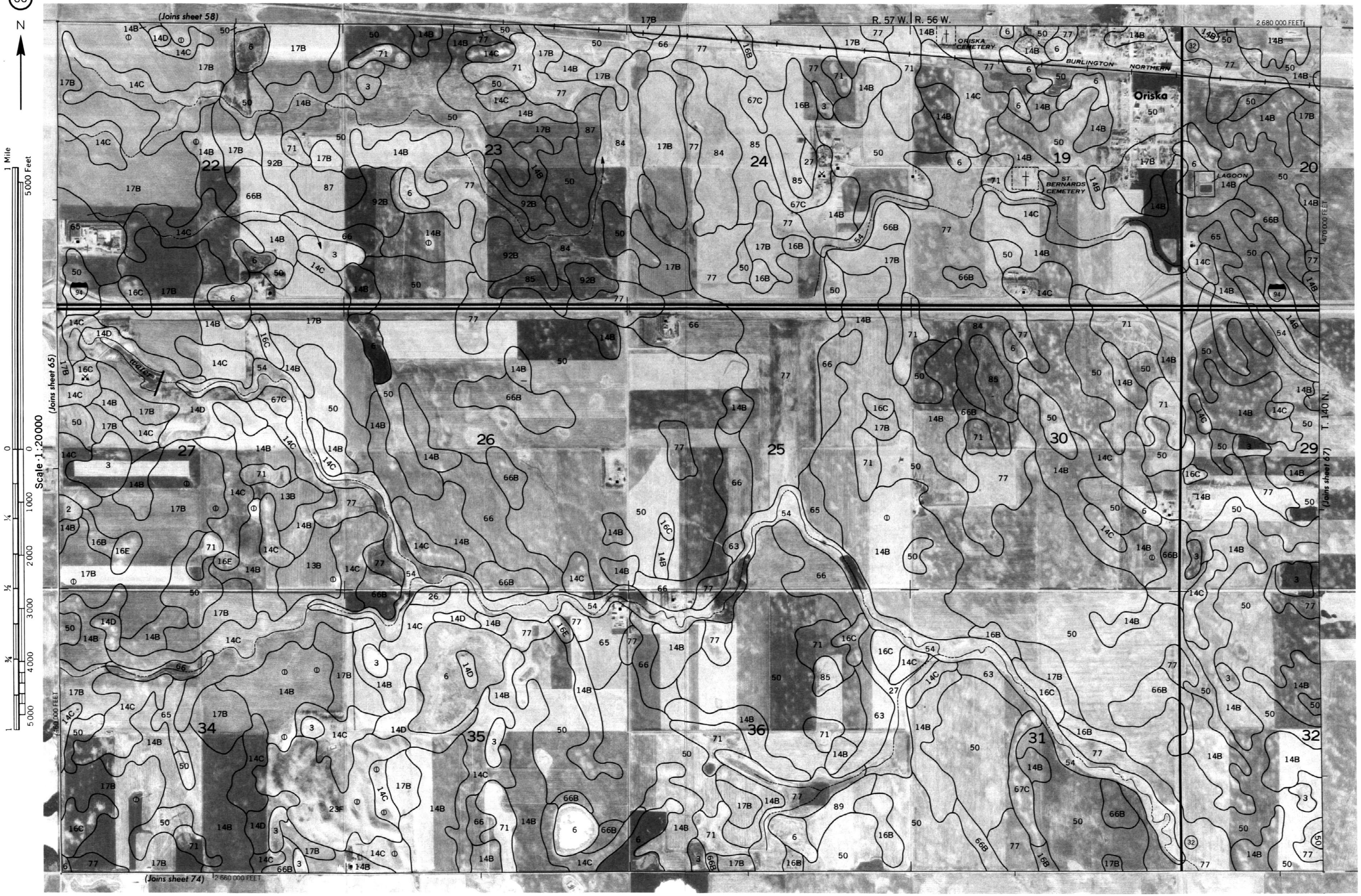


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



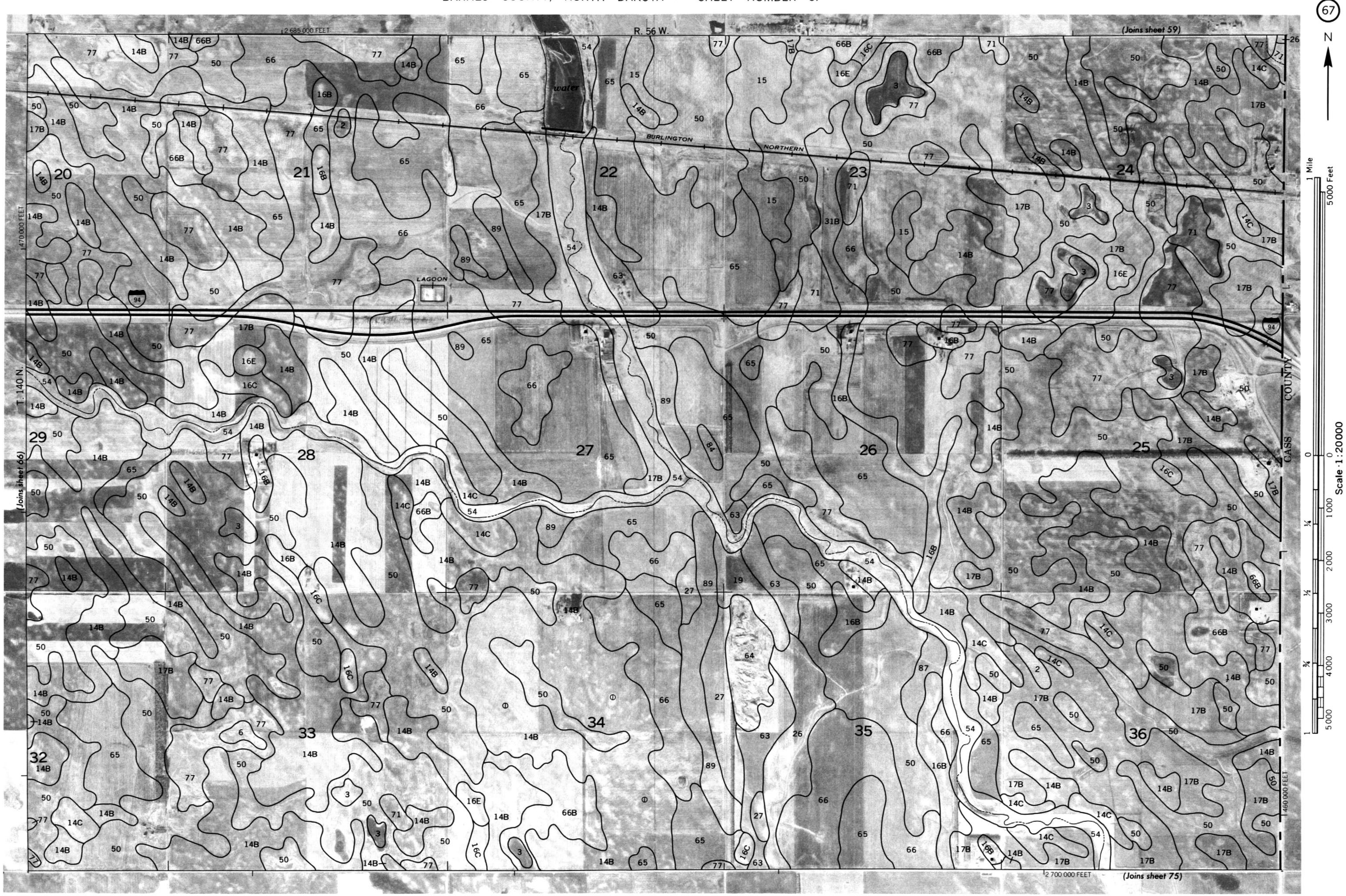
BARNES COUNTY, NORTH DAKOTA NO. 65

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

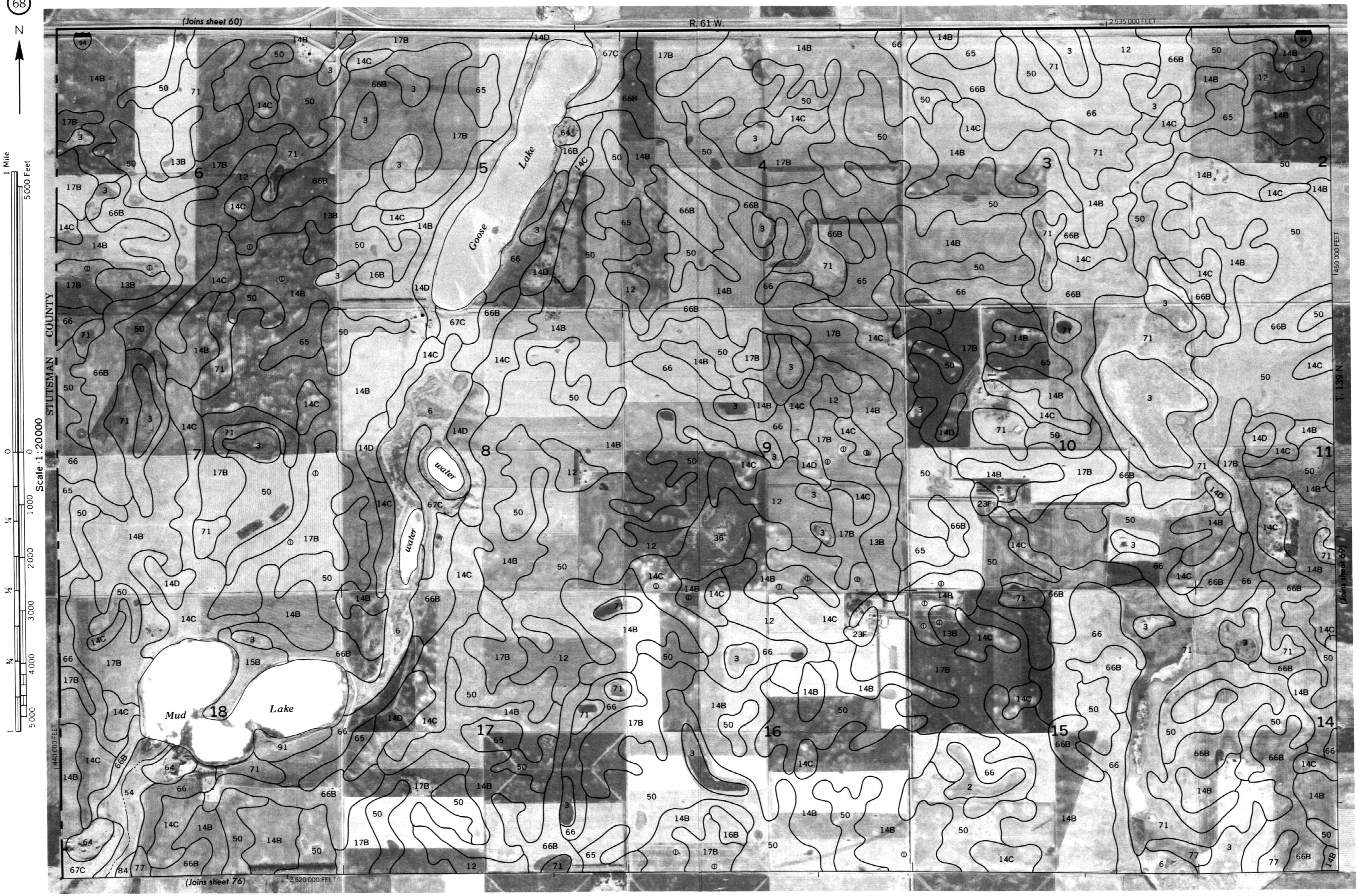
BARNES COUNTY, NORTH DAKOTA NO. 66



BARNES COUNTY, NORTH DAKOTA NO. 67

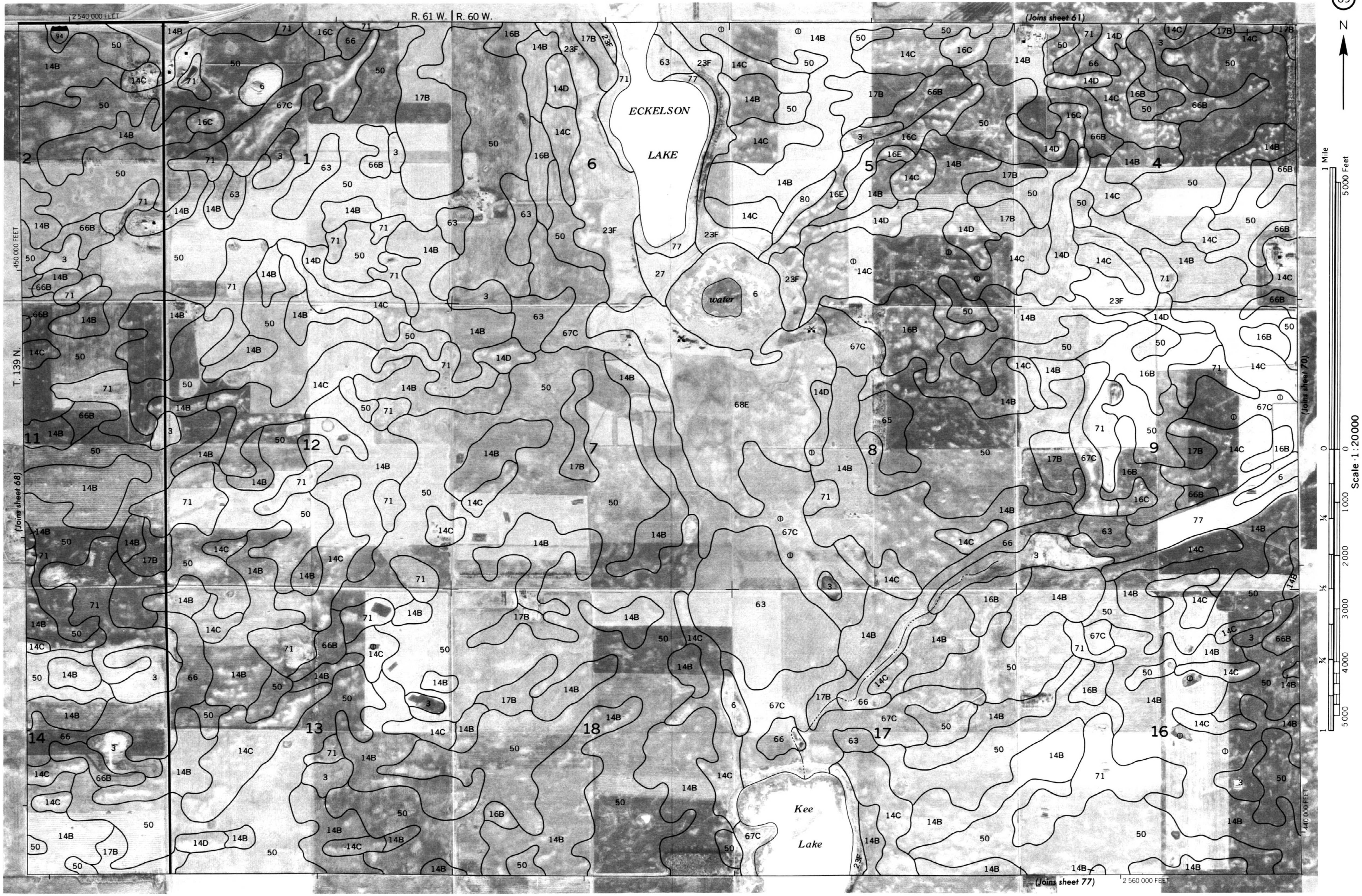
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 68



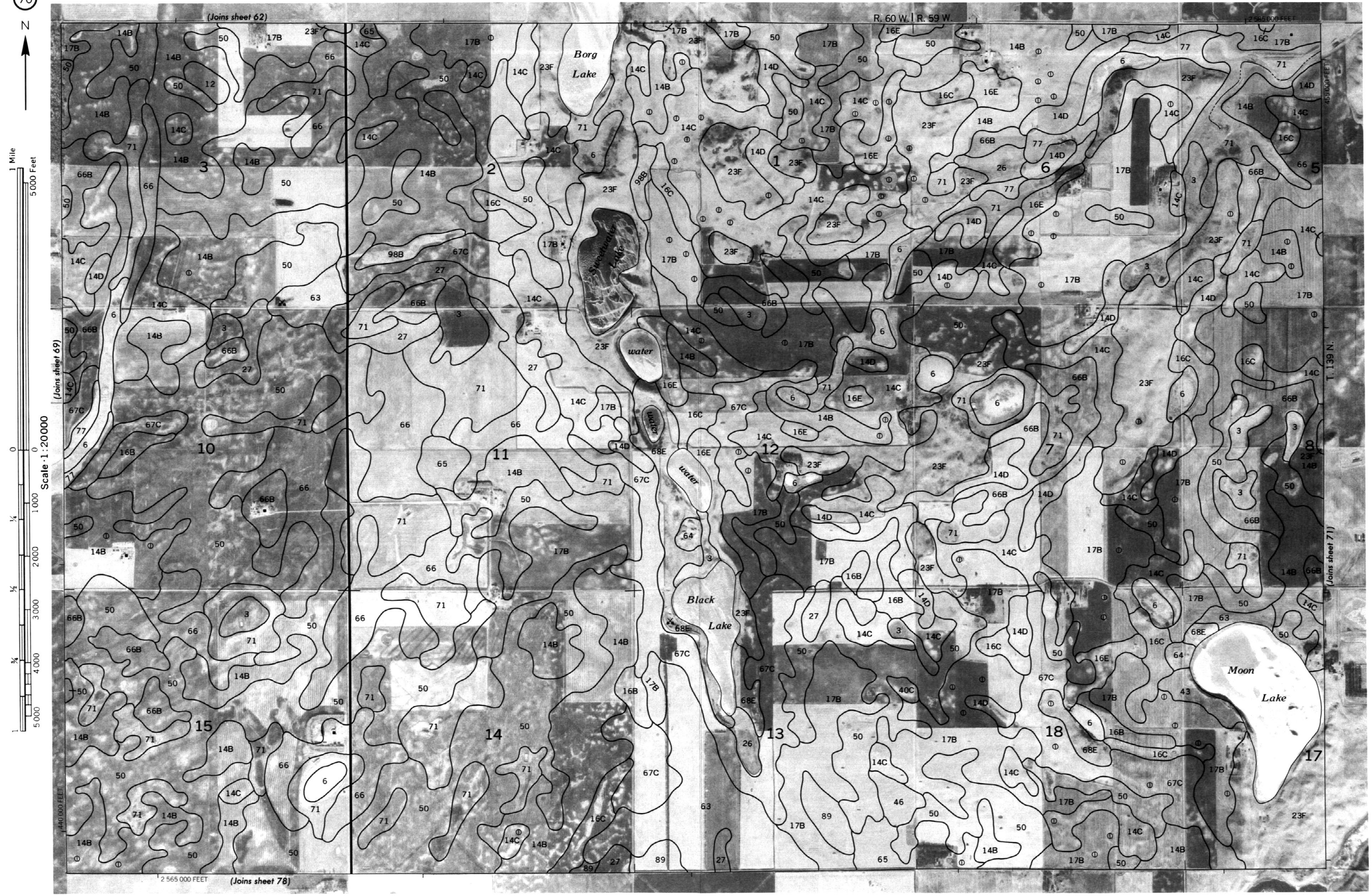
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 68



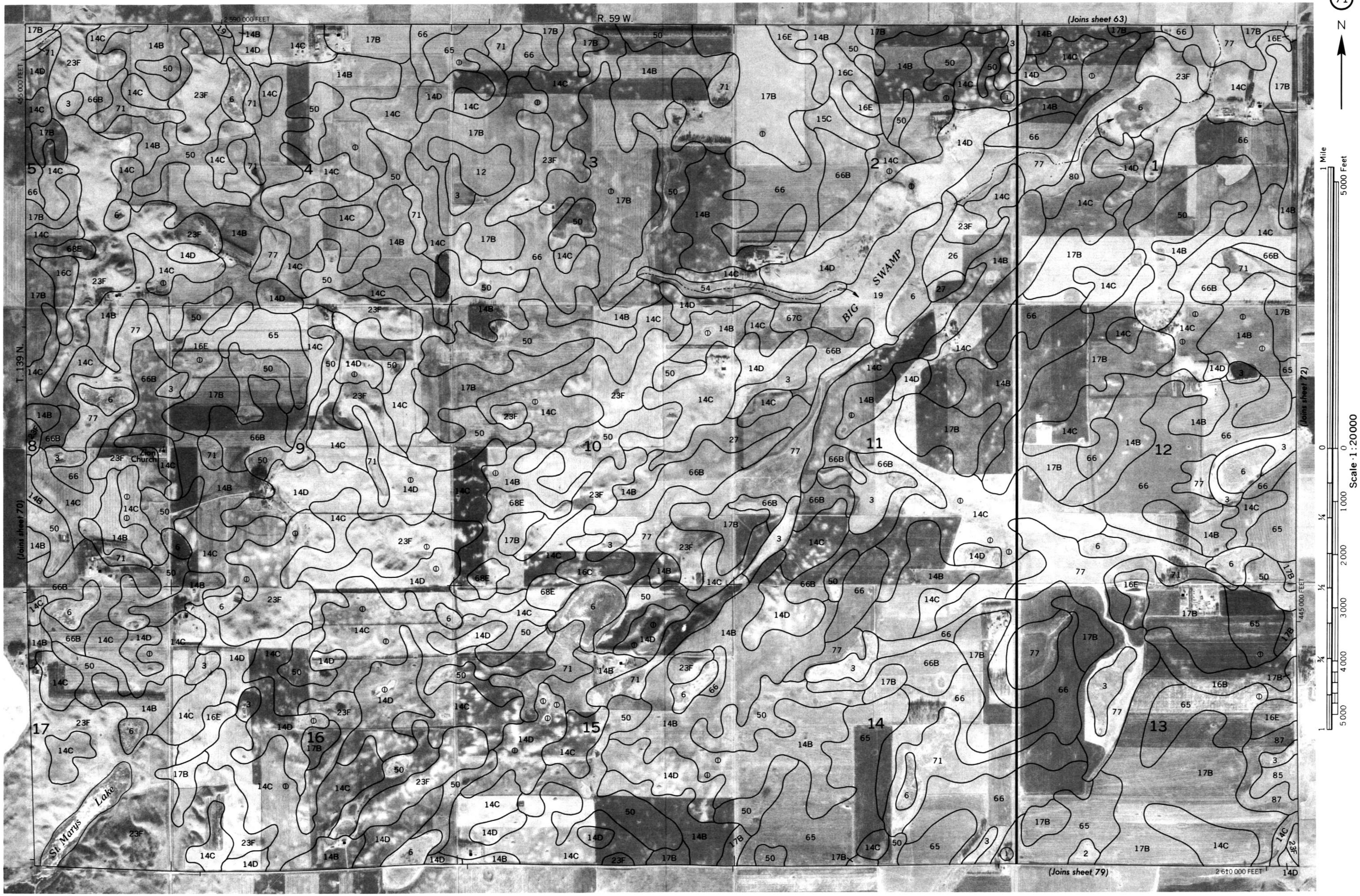
BARNES COUNTY, NORTH DAKOTA NO. 69

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



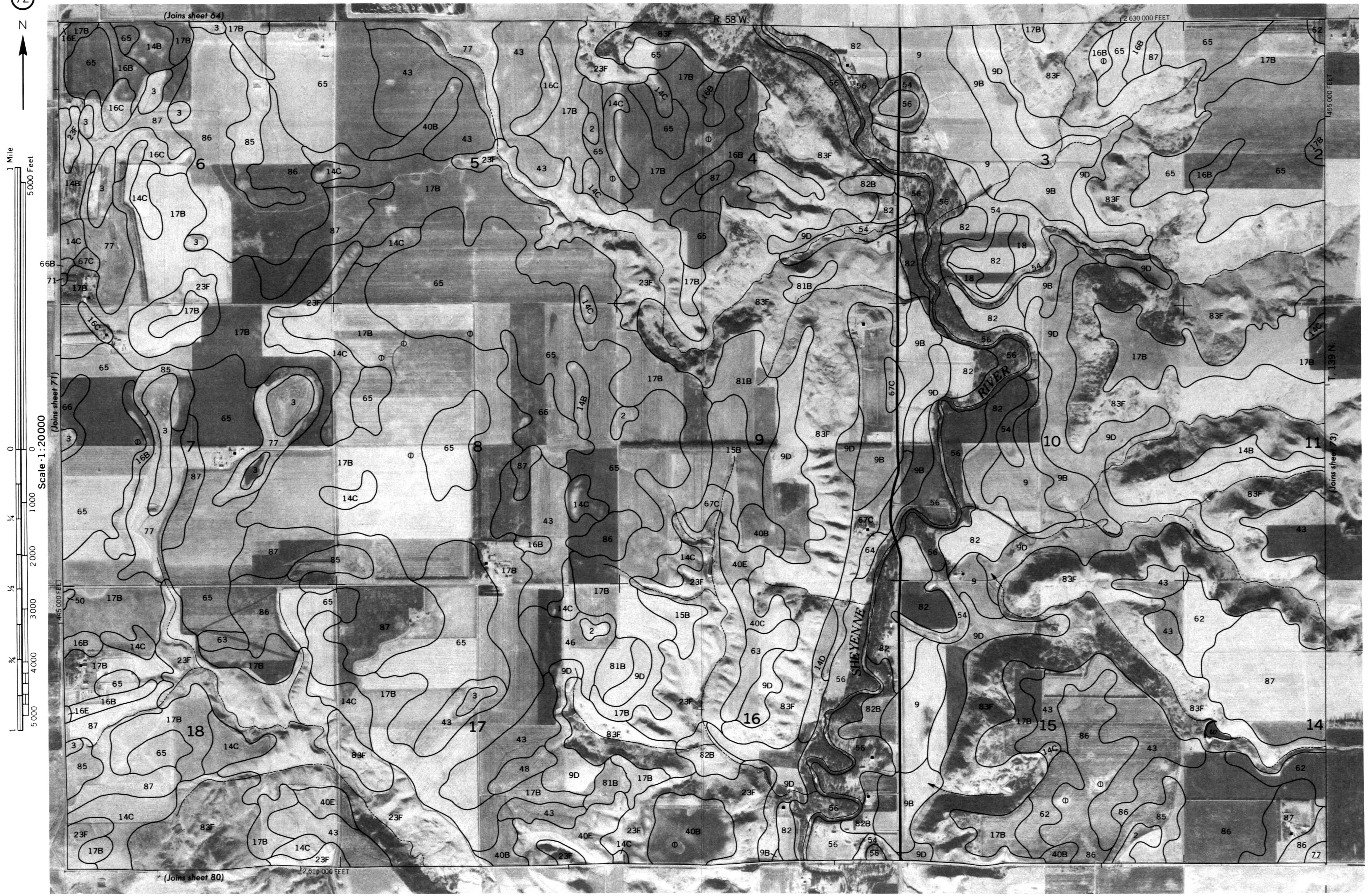
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 70



BARNES COUNTY, NORTH DAKOTA NO. 71

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

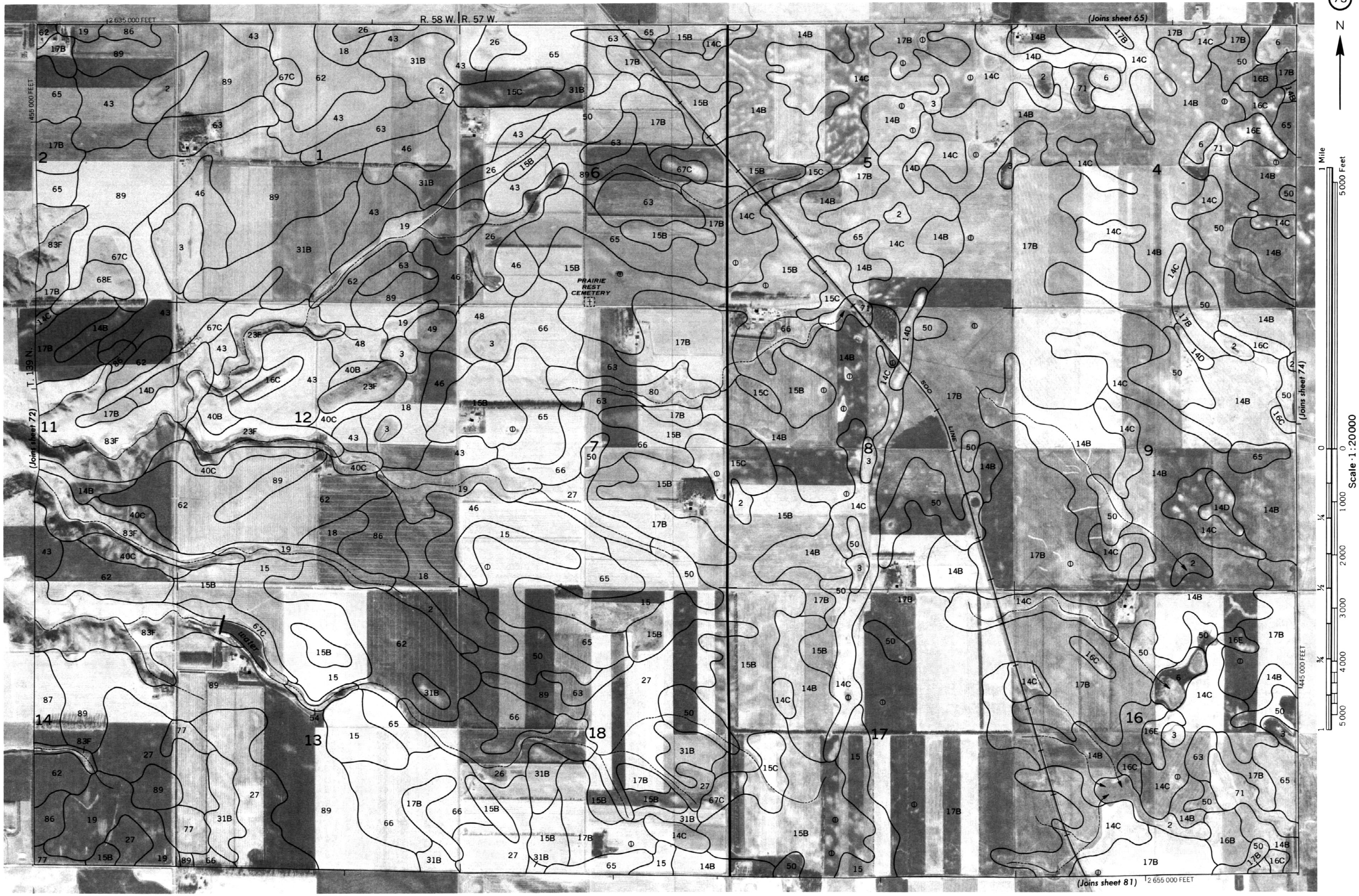


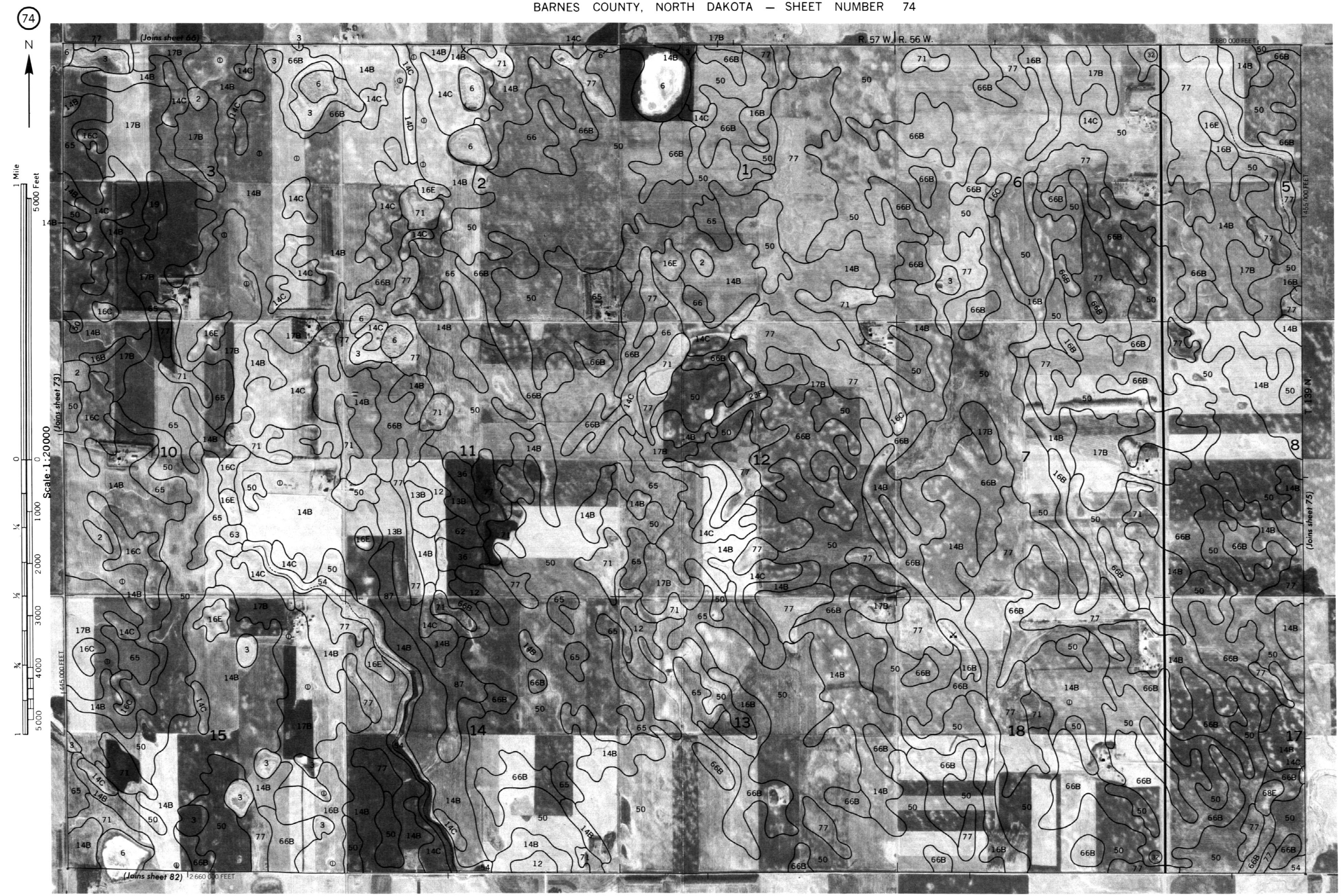
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 72

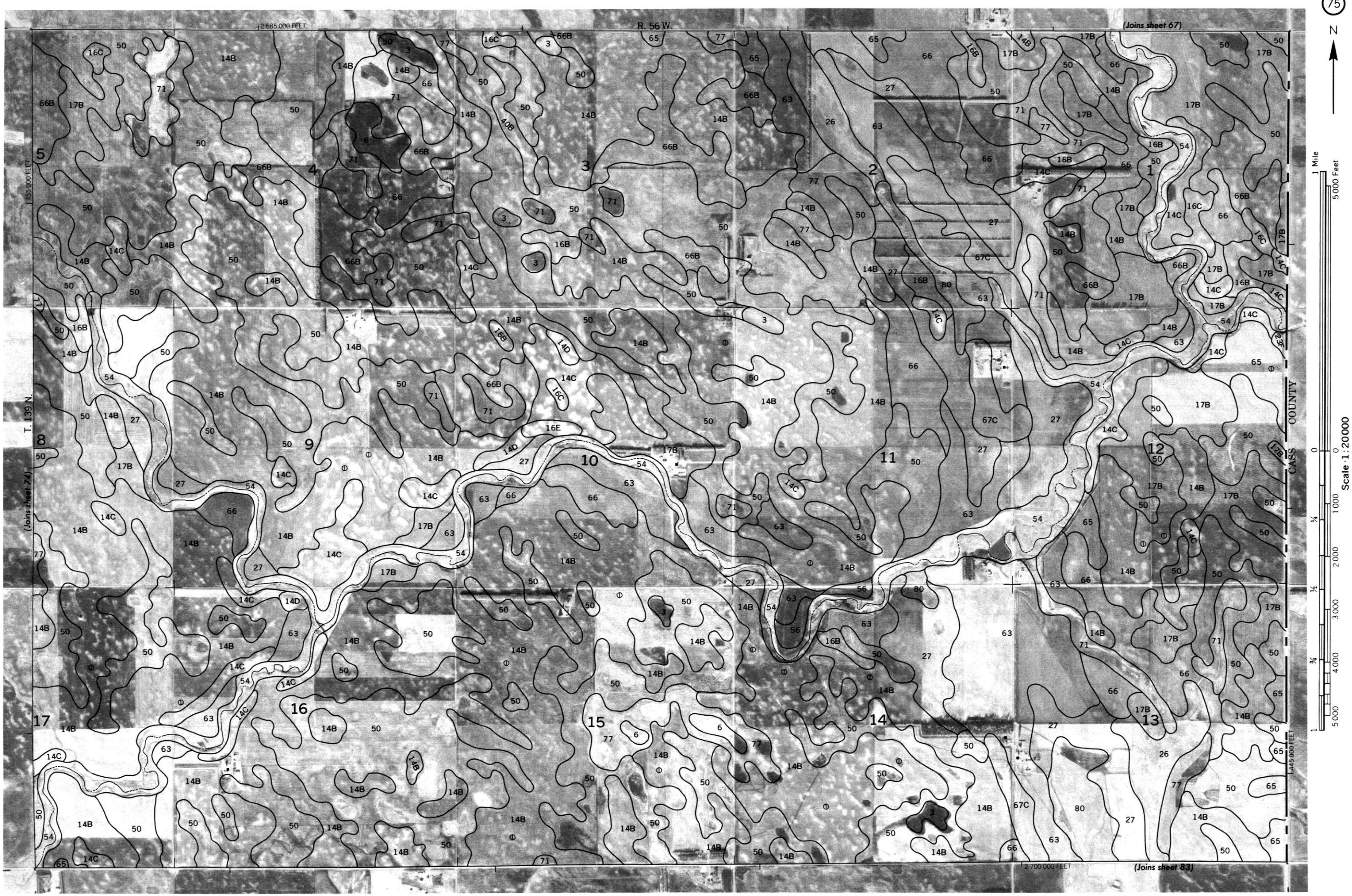
BARNES COUNTY, NORTH DAKOTA NO. 73

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



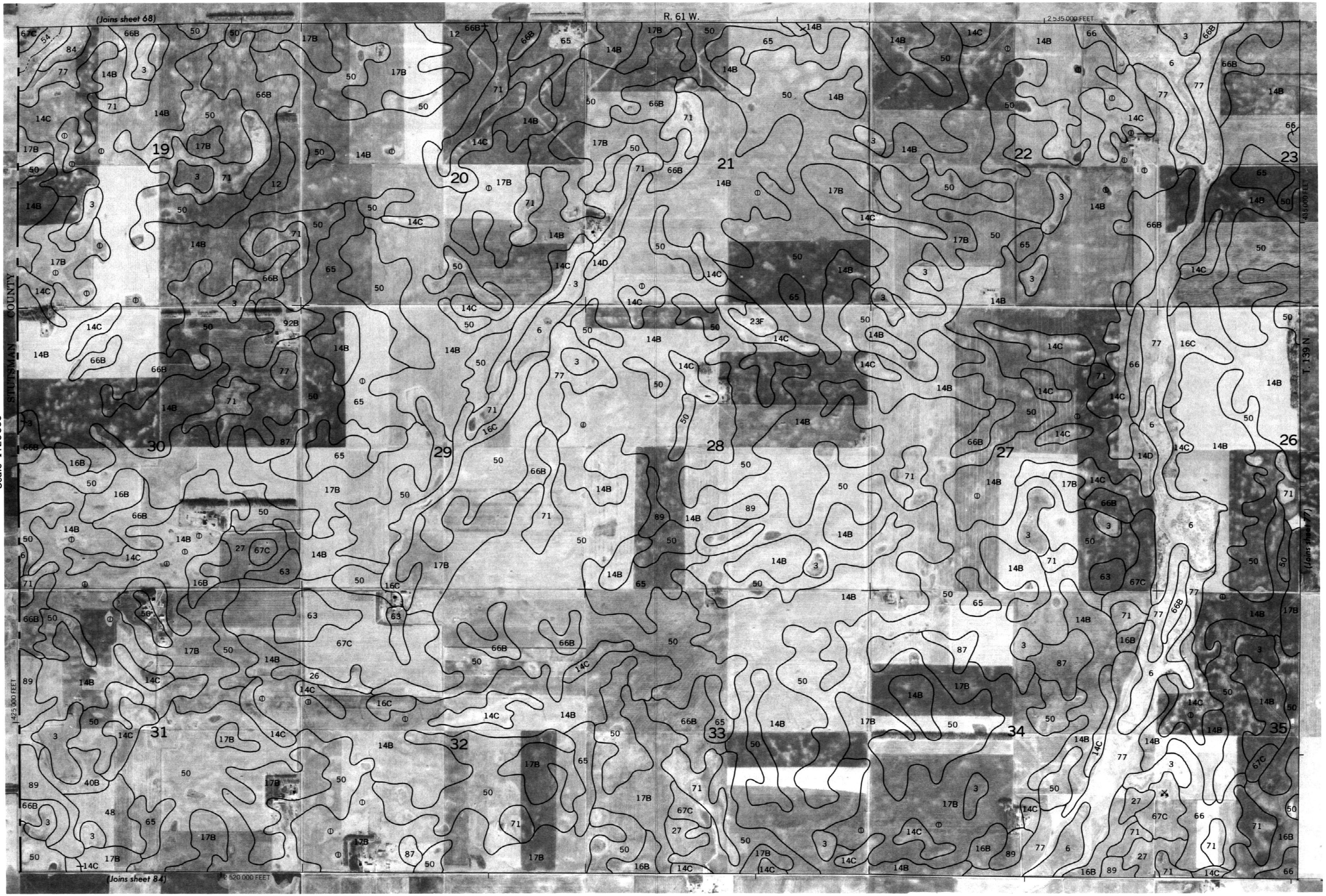
BARNES COUNTY, NORTH DAKOTA NO. 75

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

76

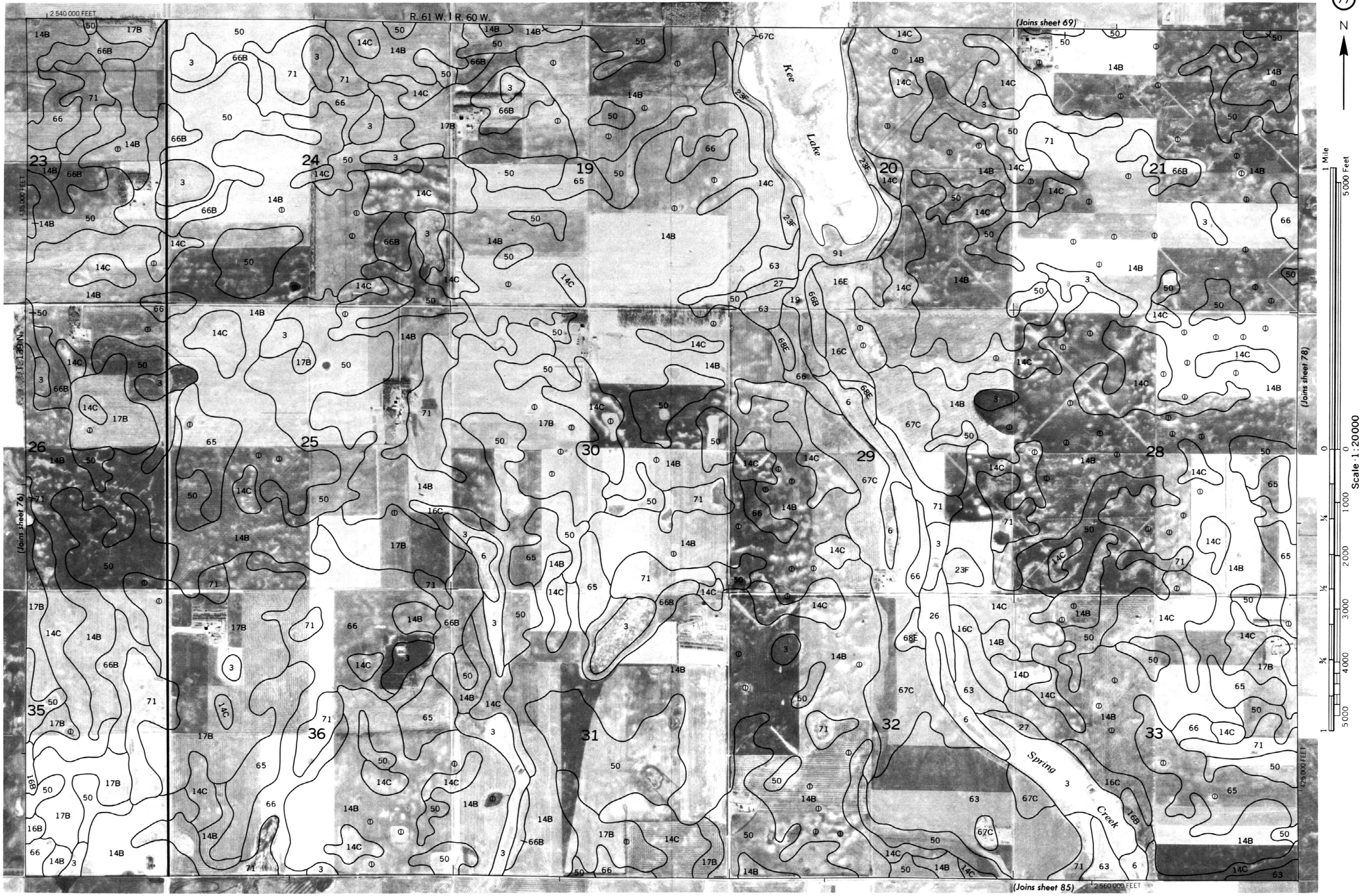
N

1 Mile
5000 Feet
Scale 1:20000



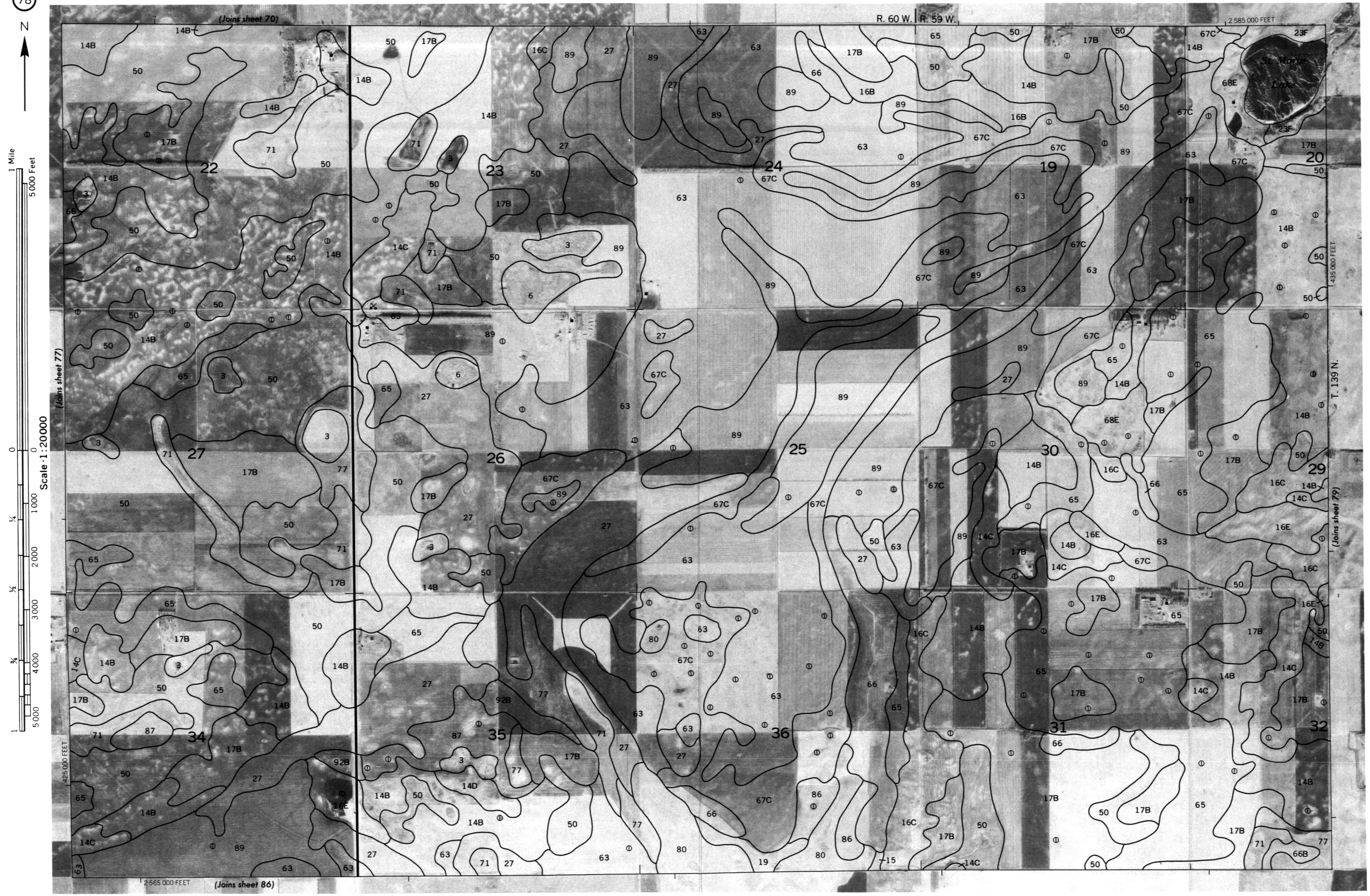
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 76



BARNES COUNTY, NORTH DAKOTA NO. 77

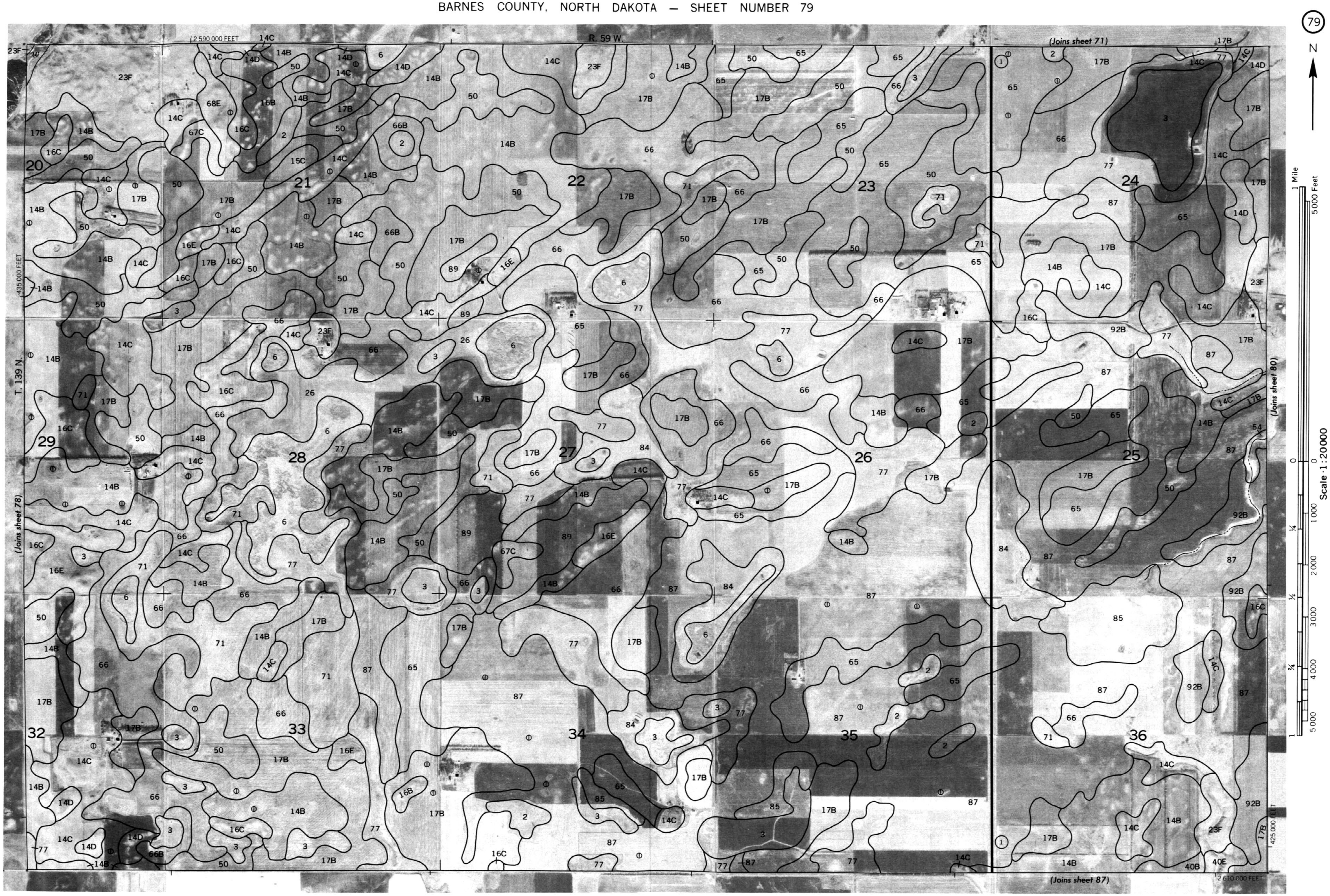
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 79

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



80

N

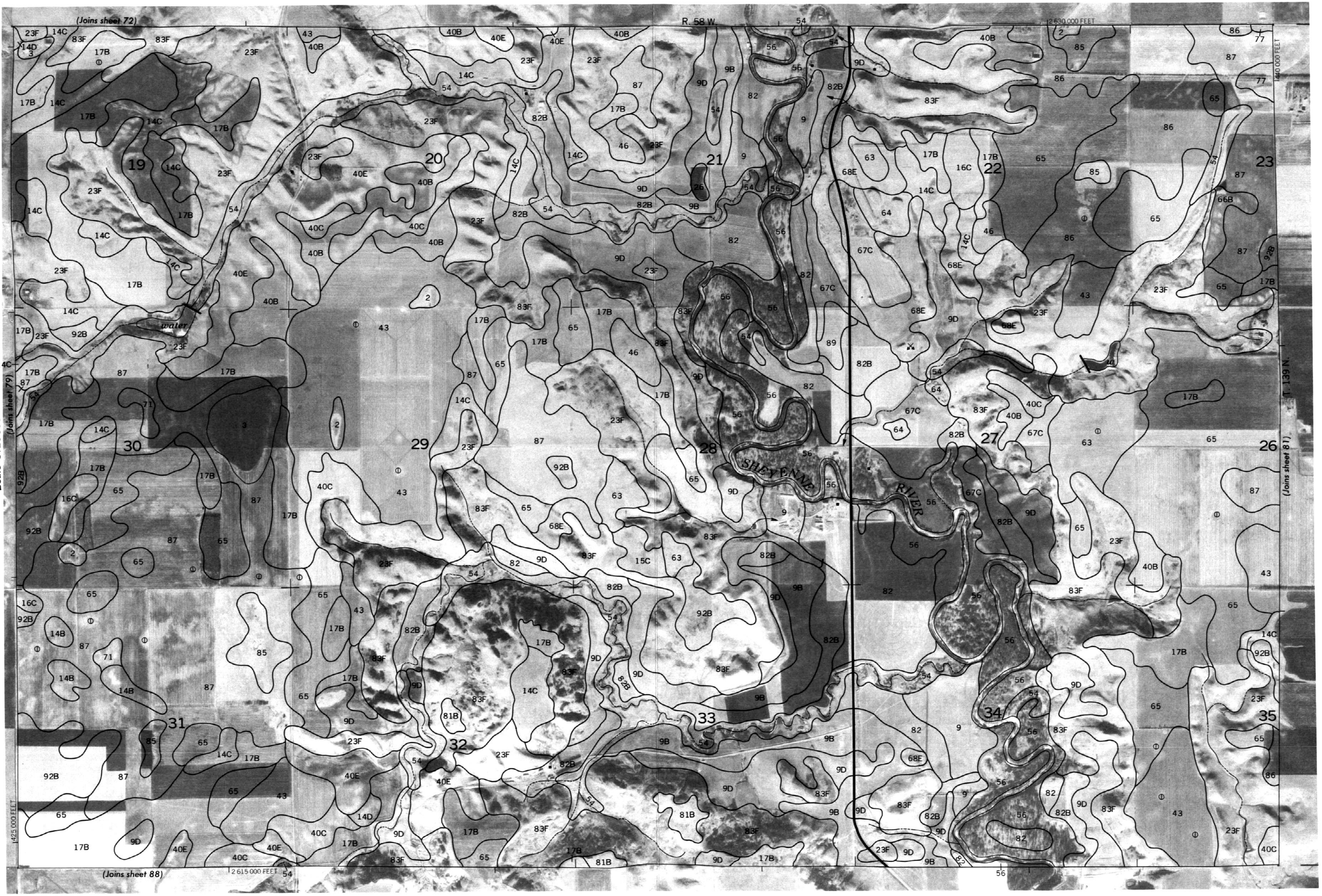
1 Mile

5000 Feet

Scale 1:20000

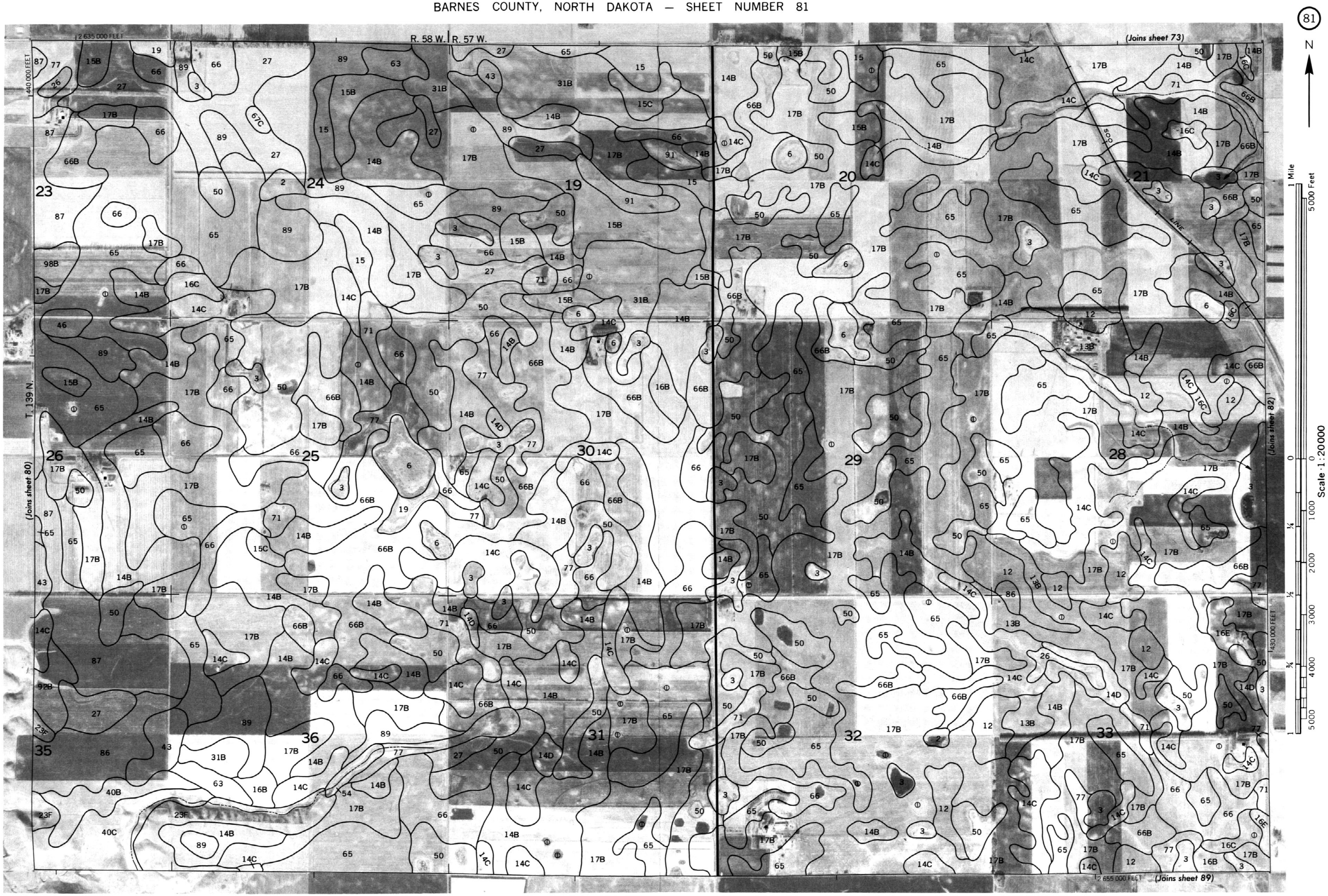
0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000



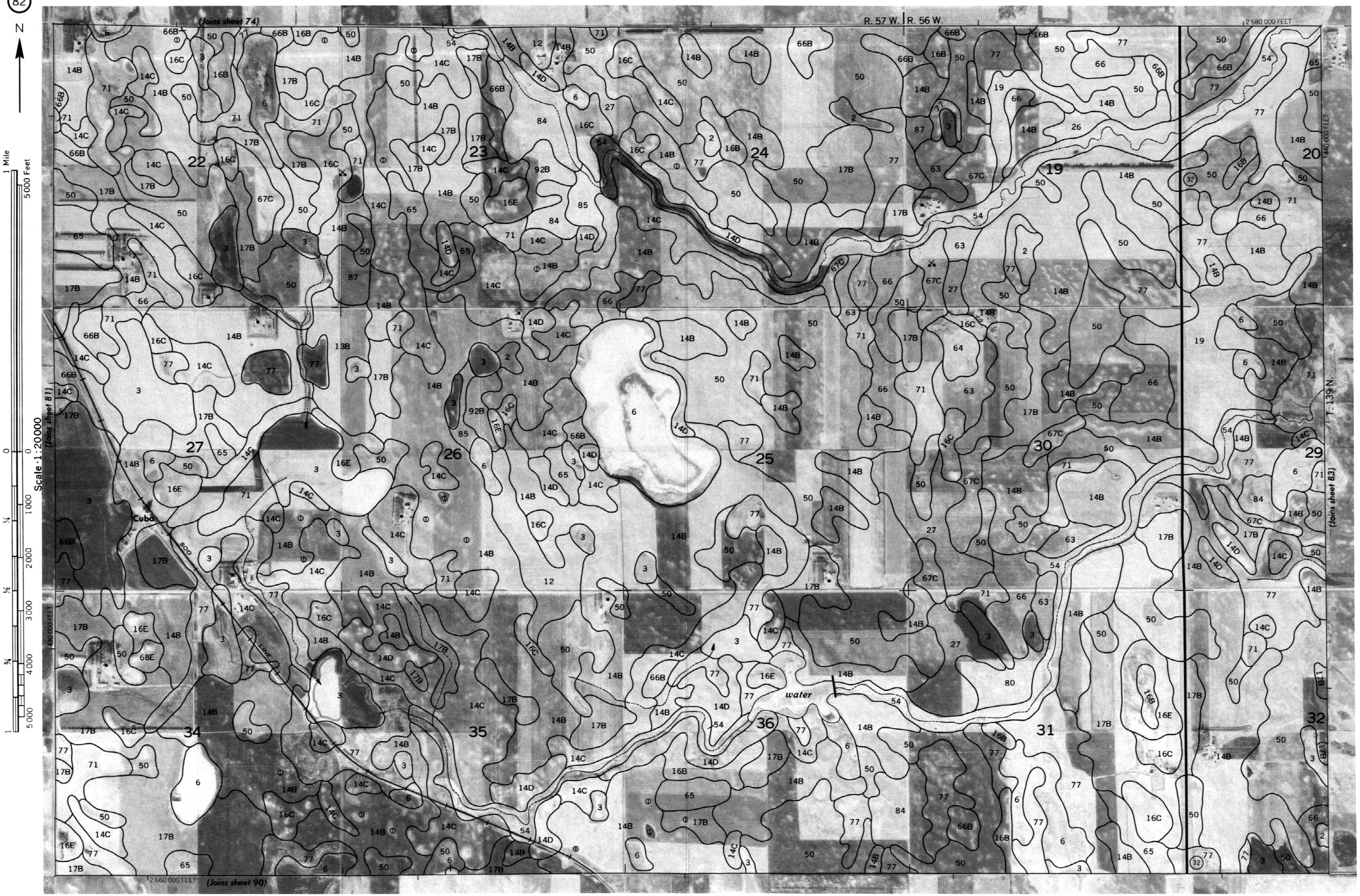
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 80



BARNES COUNTY, NORTH DAKOTA NO. 81

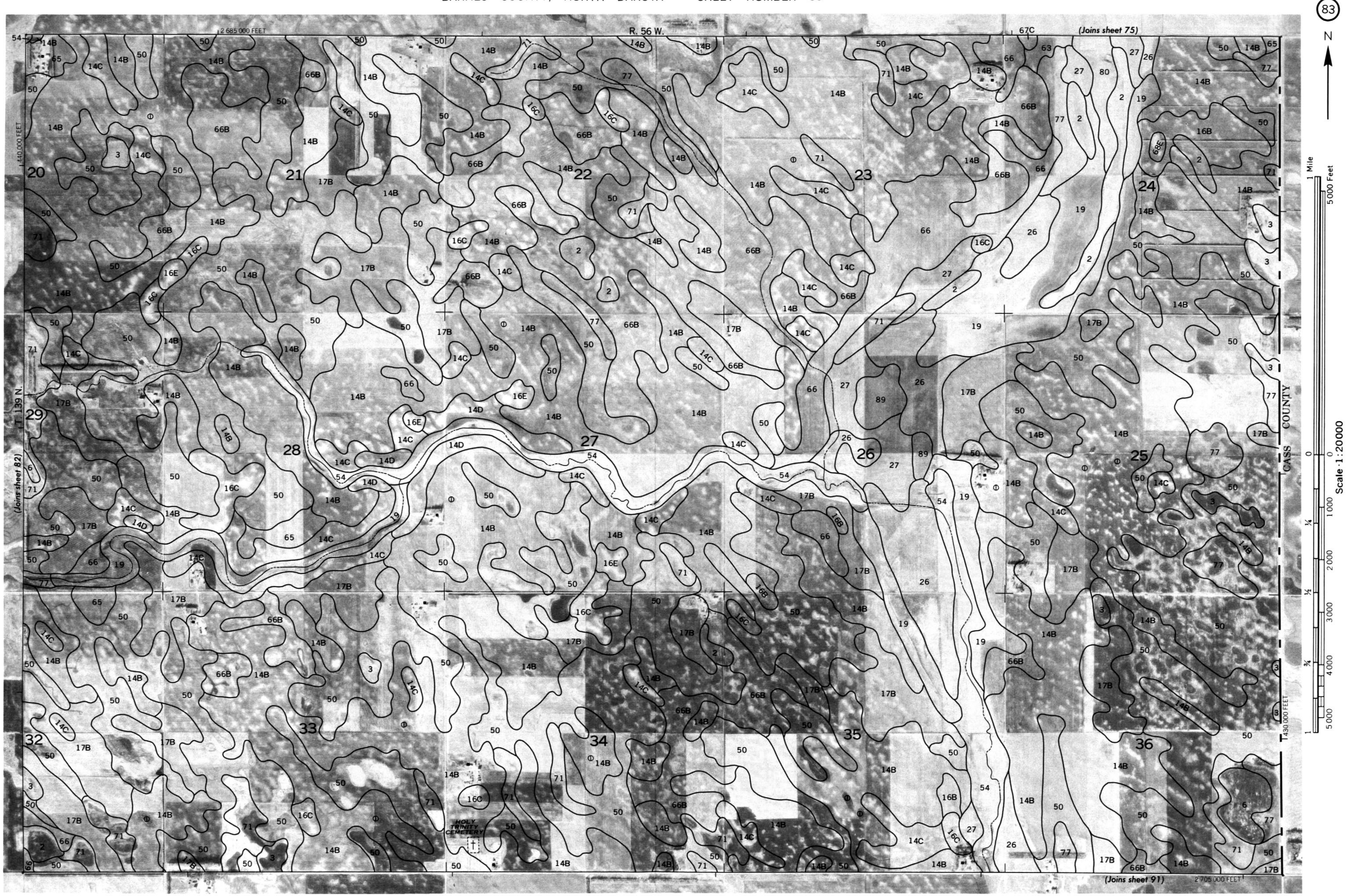
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

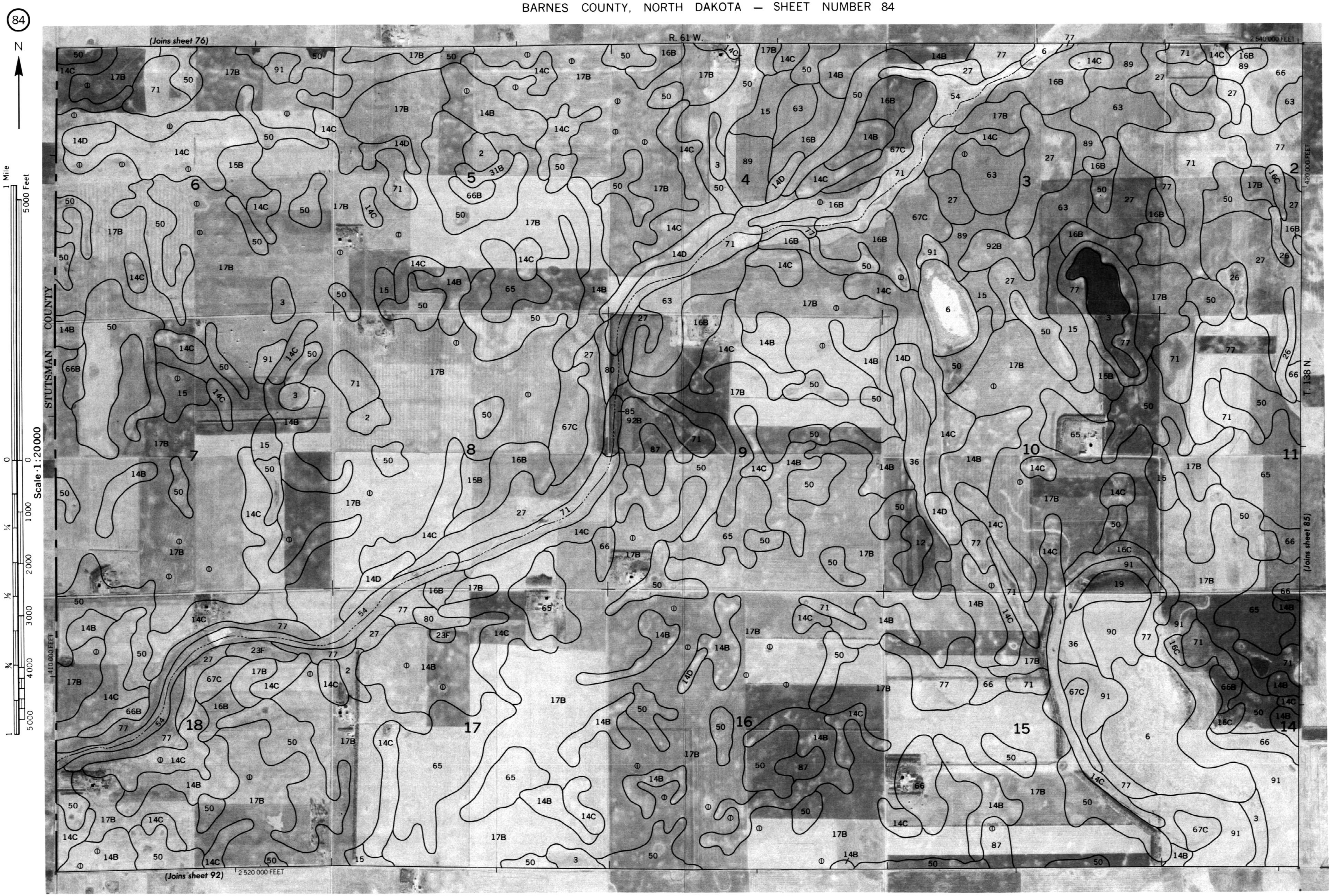


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 83

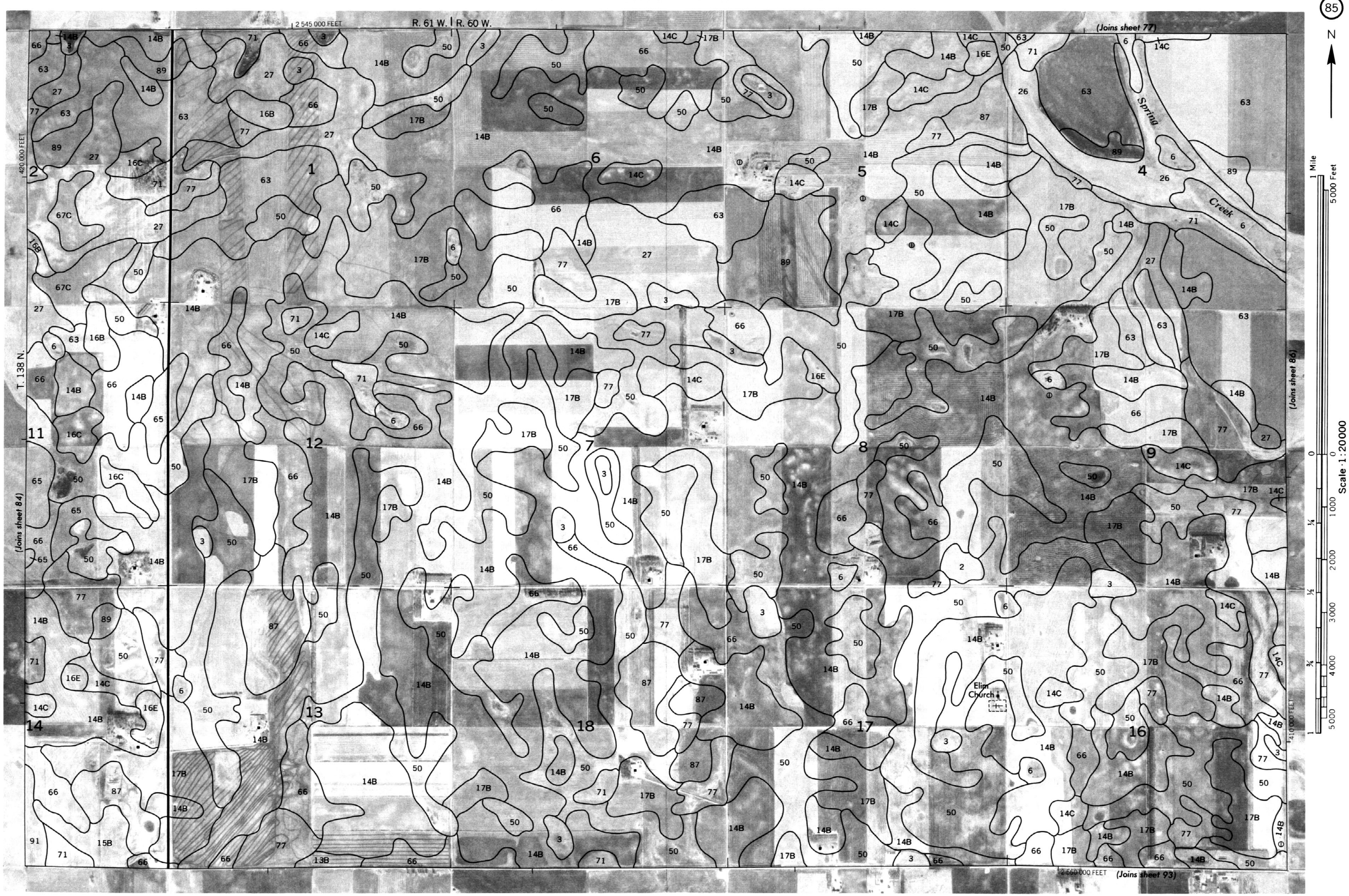
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





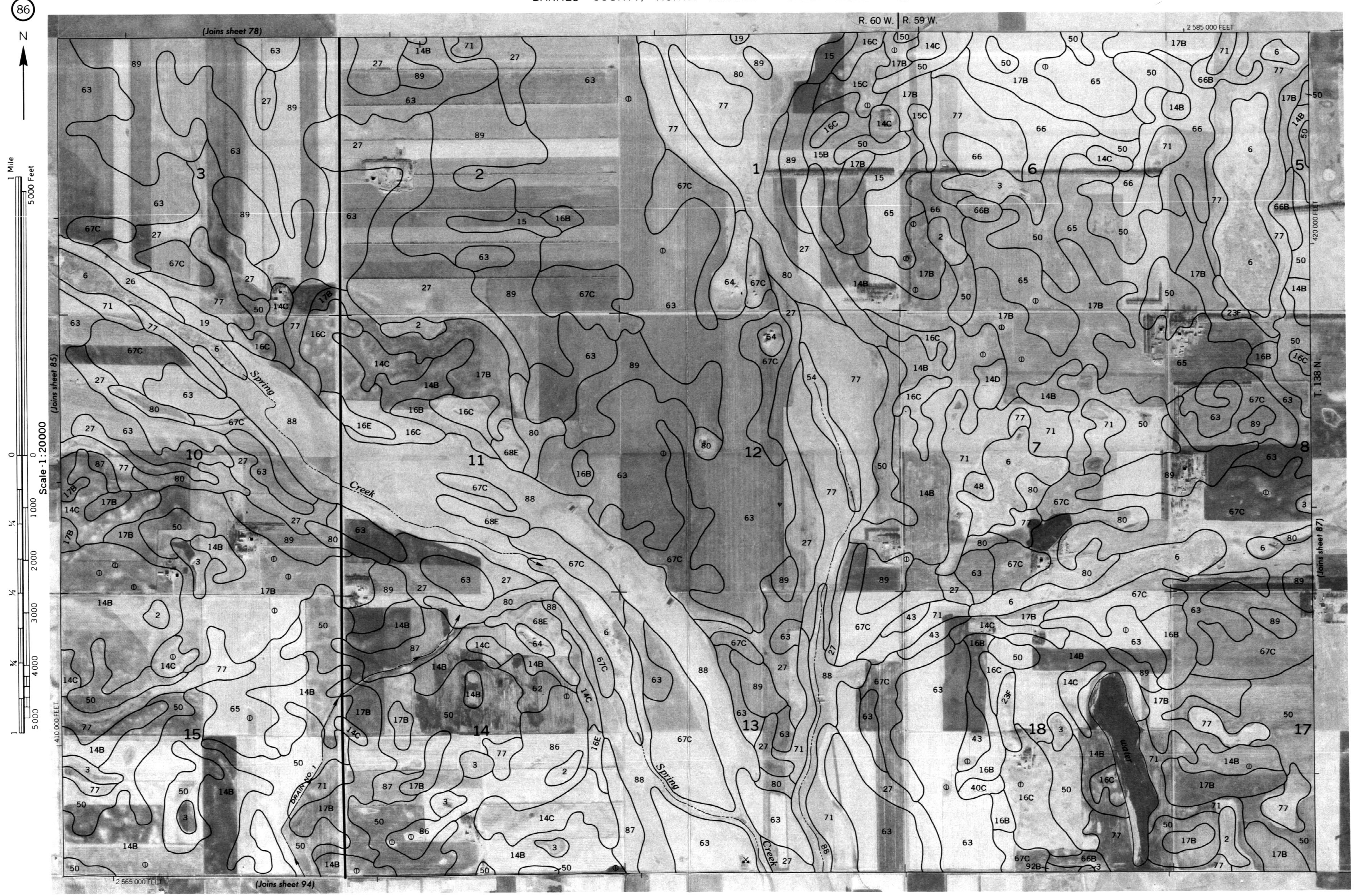
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 84

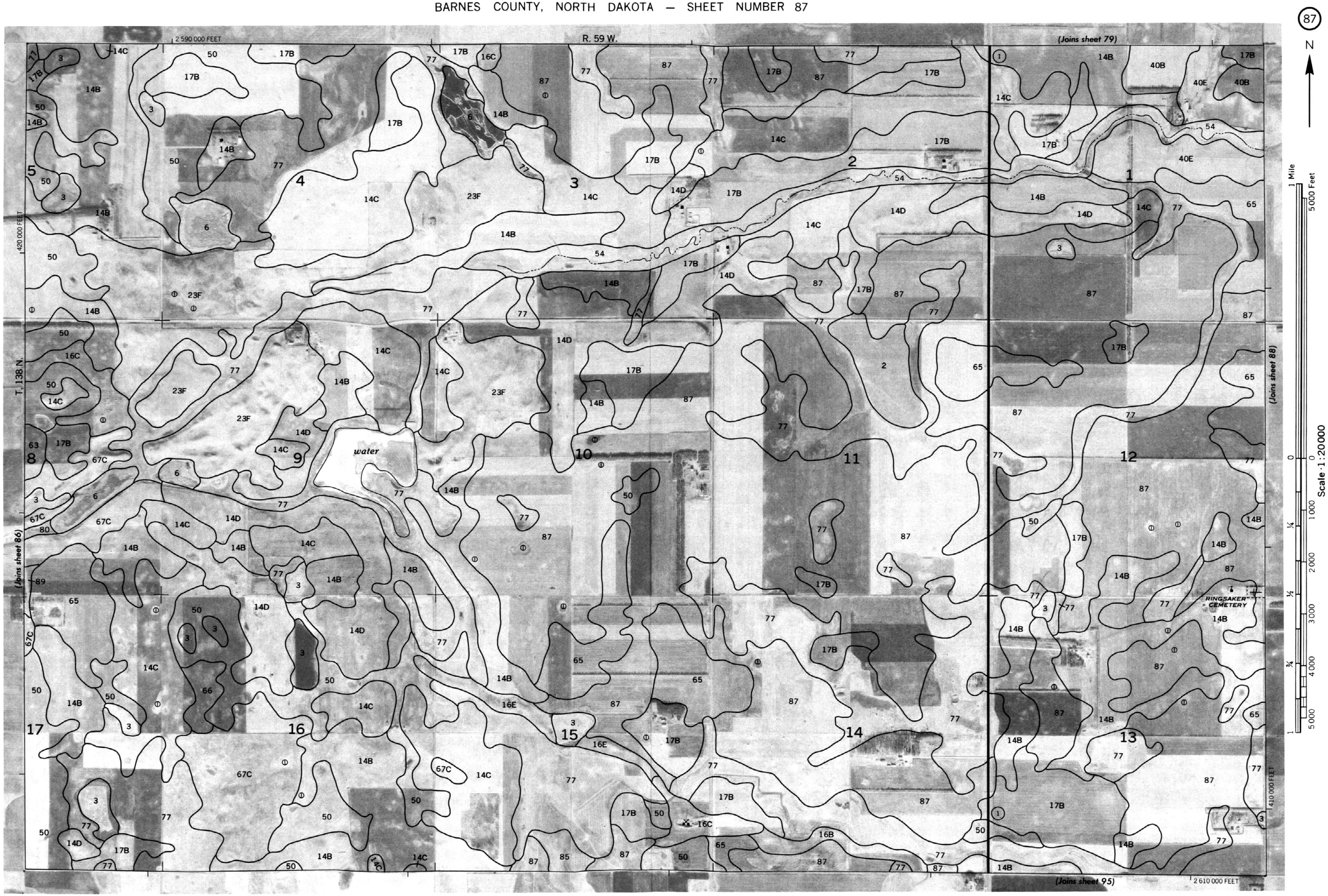


BARNES COUNTY, NORTH DAKOTA NO. 85

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

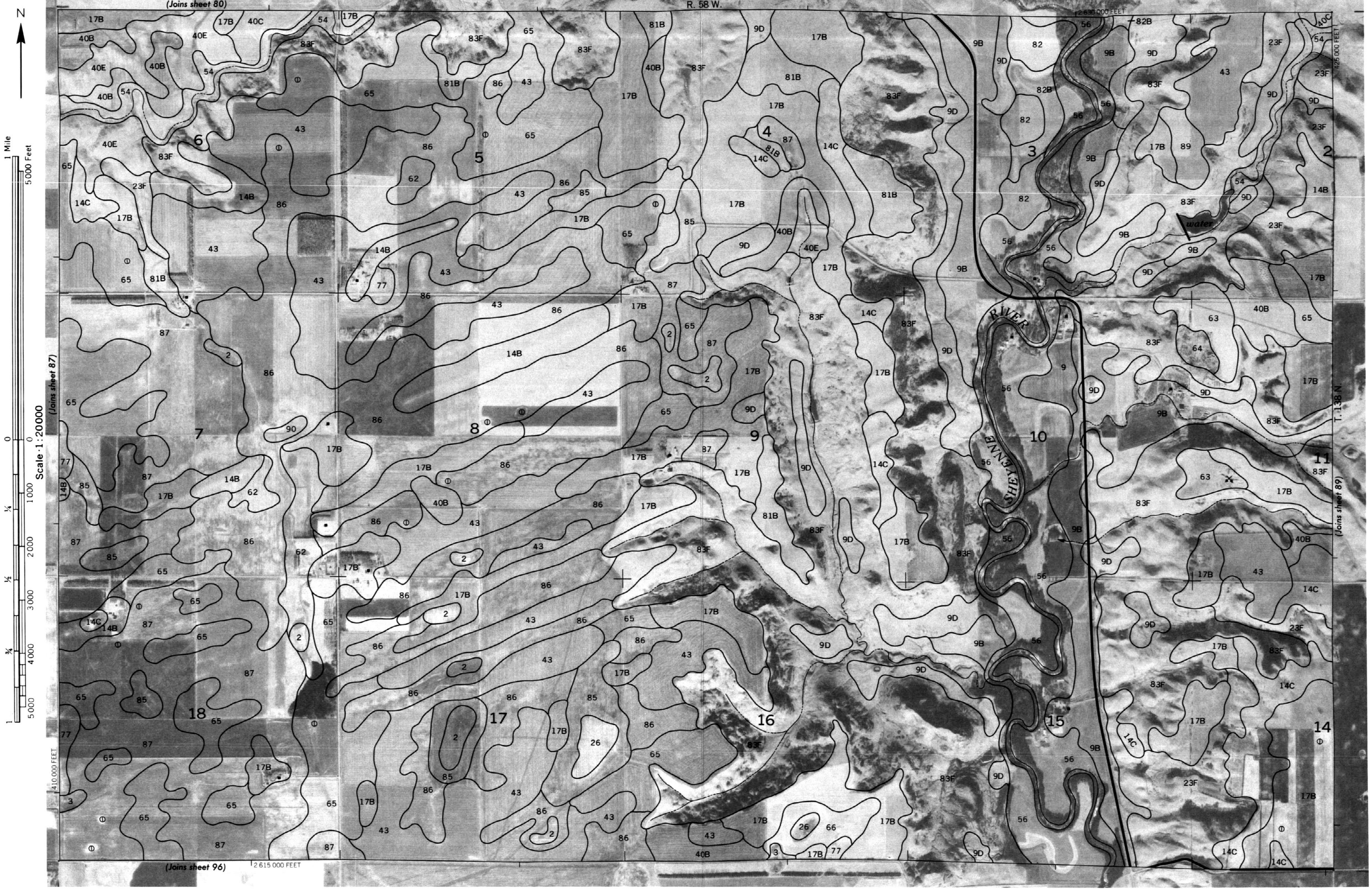


This map is compiled on 1976 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



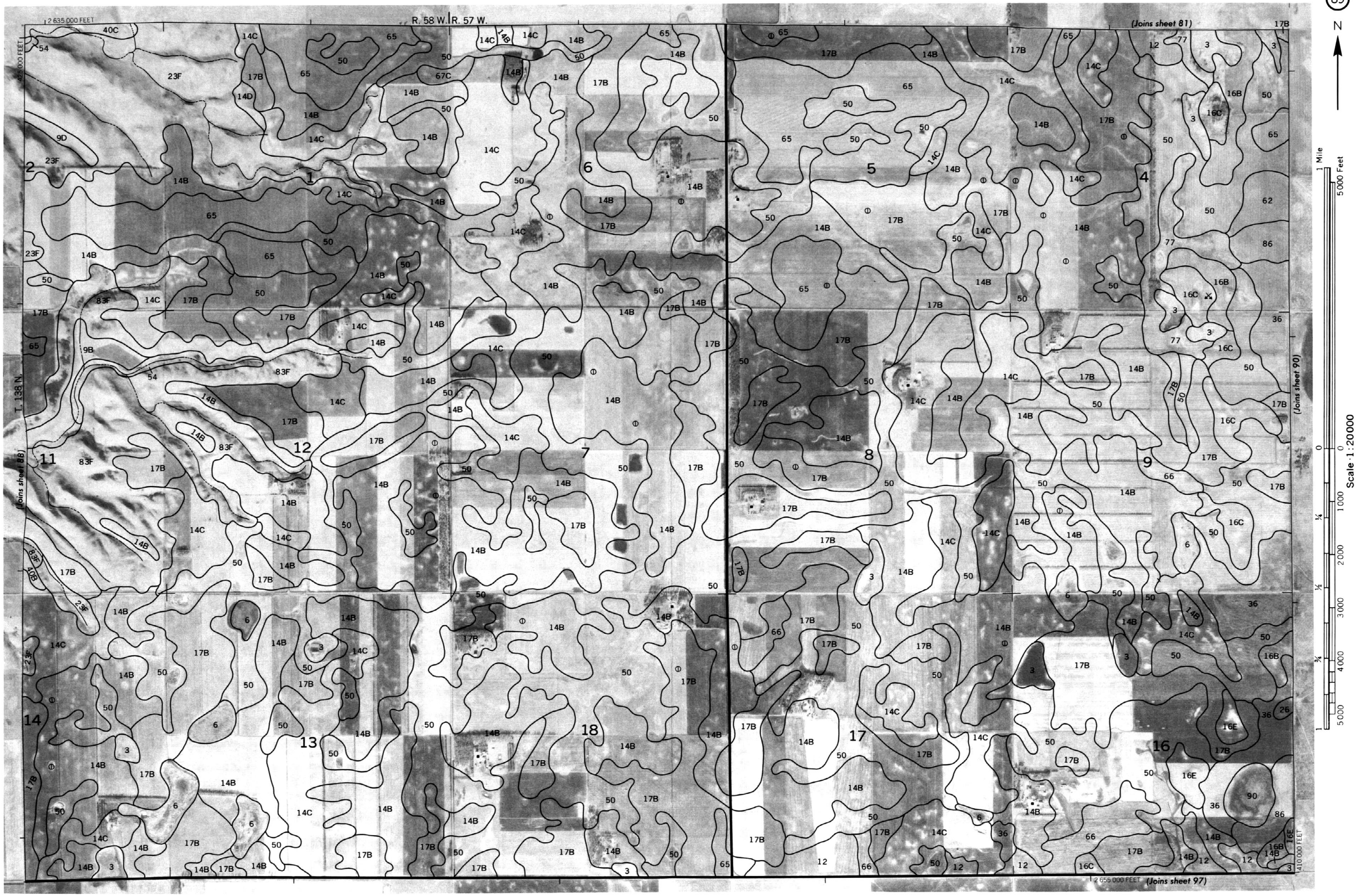
BARNES COUNTY, NORTH DAKOTA NO. 87

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



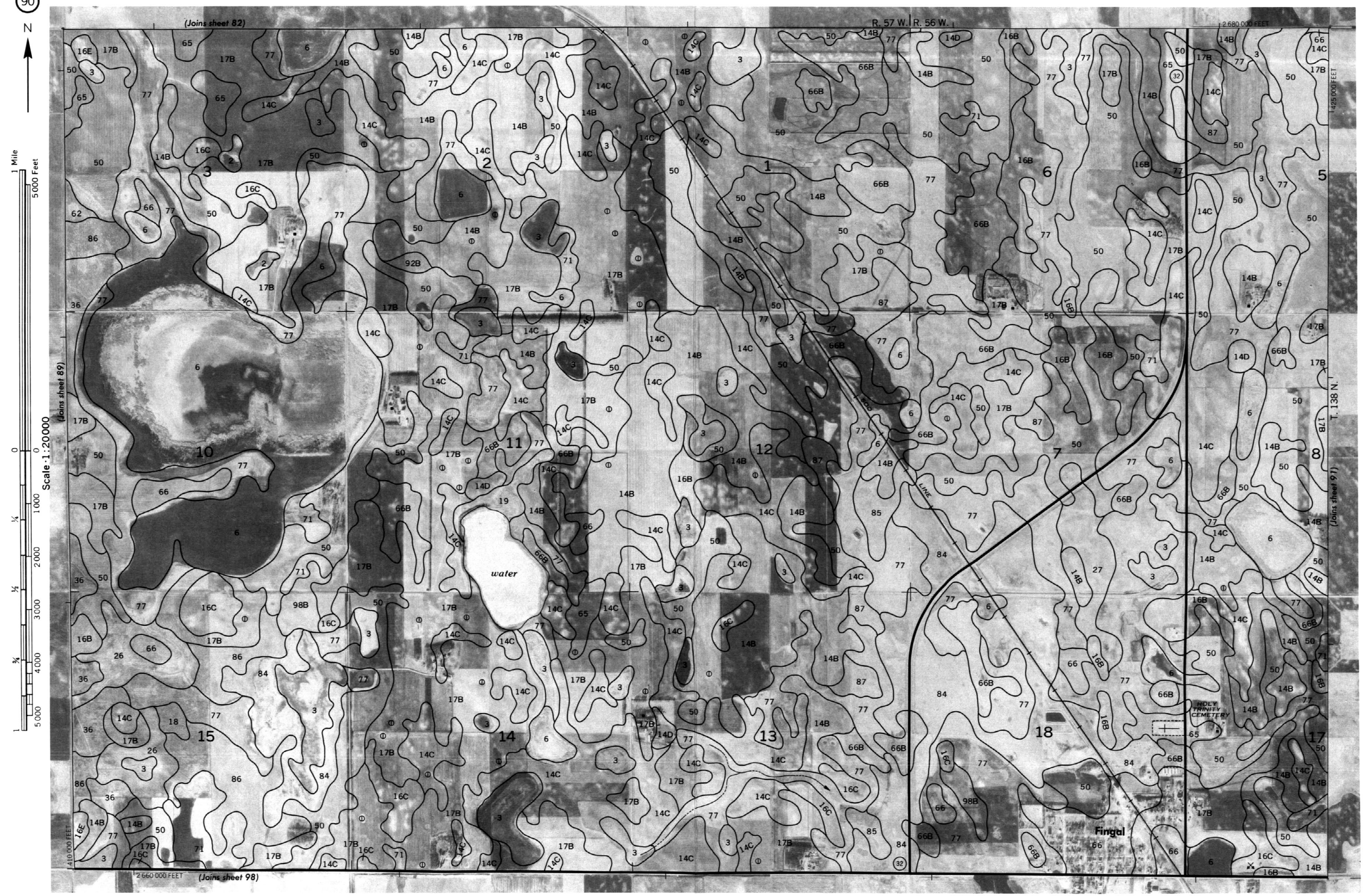
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 88



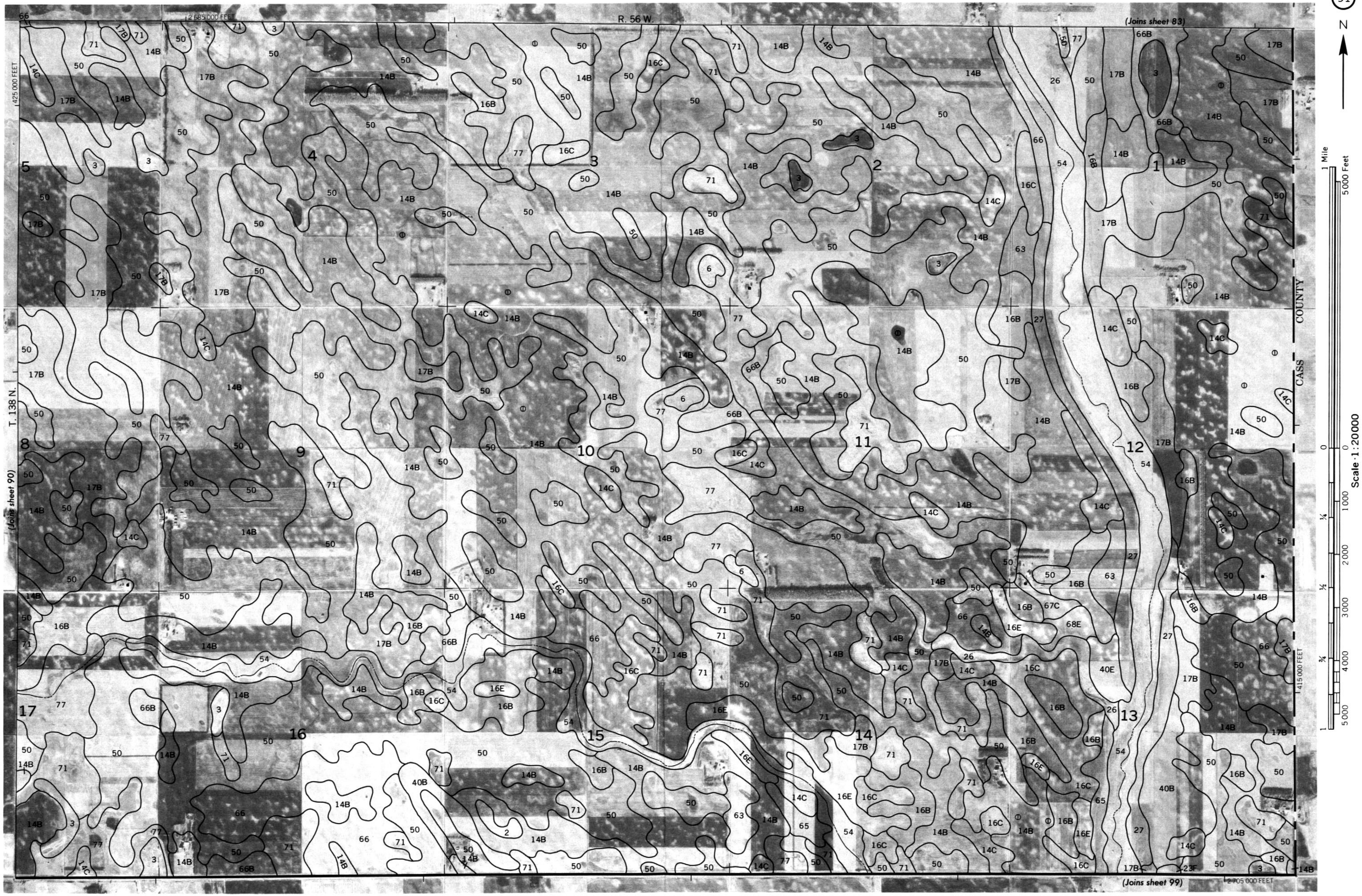
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 90



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 90



BARNES COUNTY, NORTH DAKOTA NO. 91

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 92

N

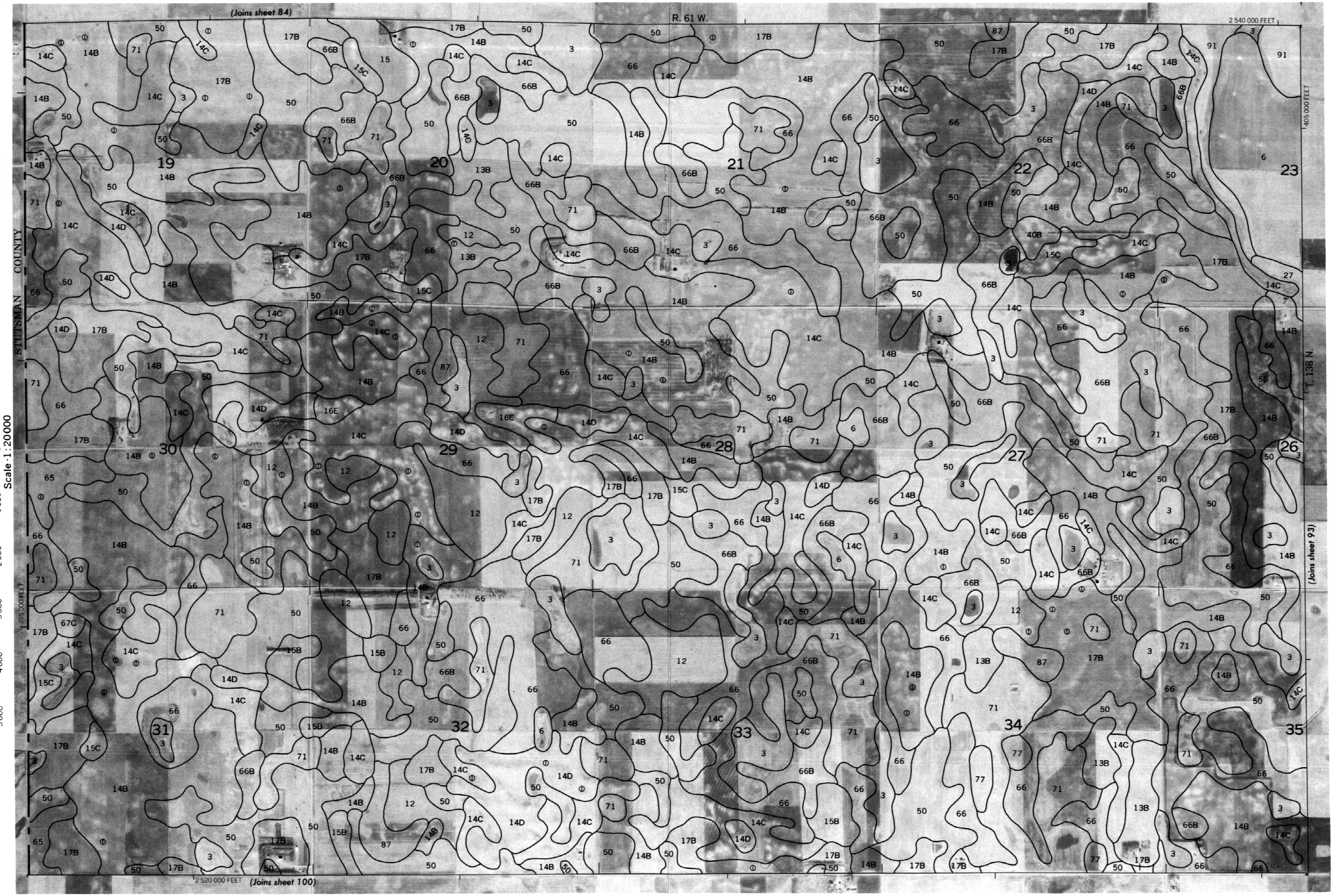
1 Mile

5 000 Feet

Scale 1:20000

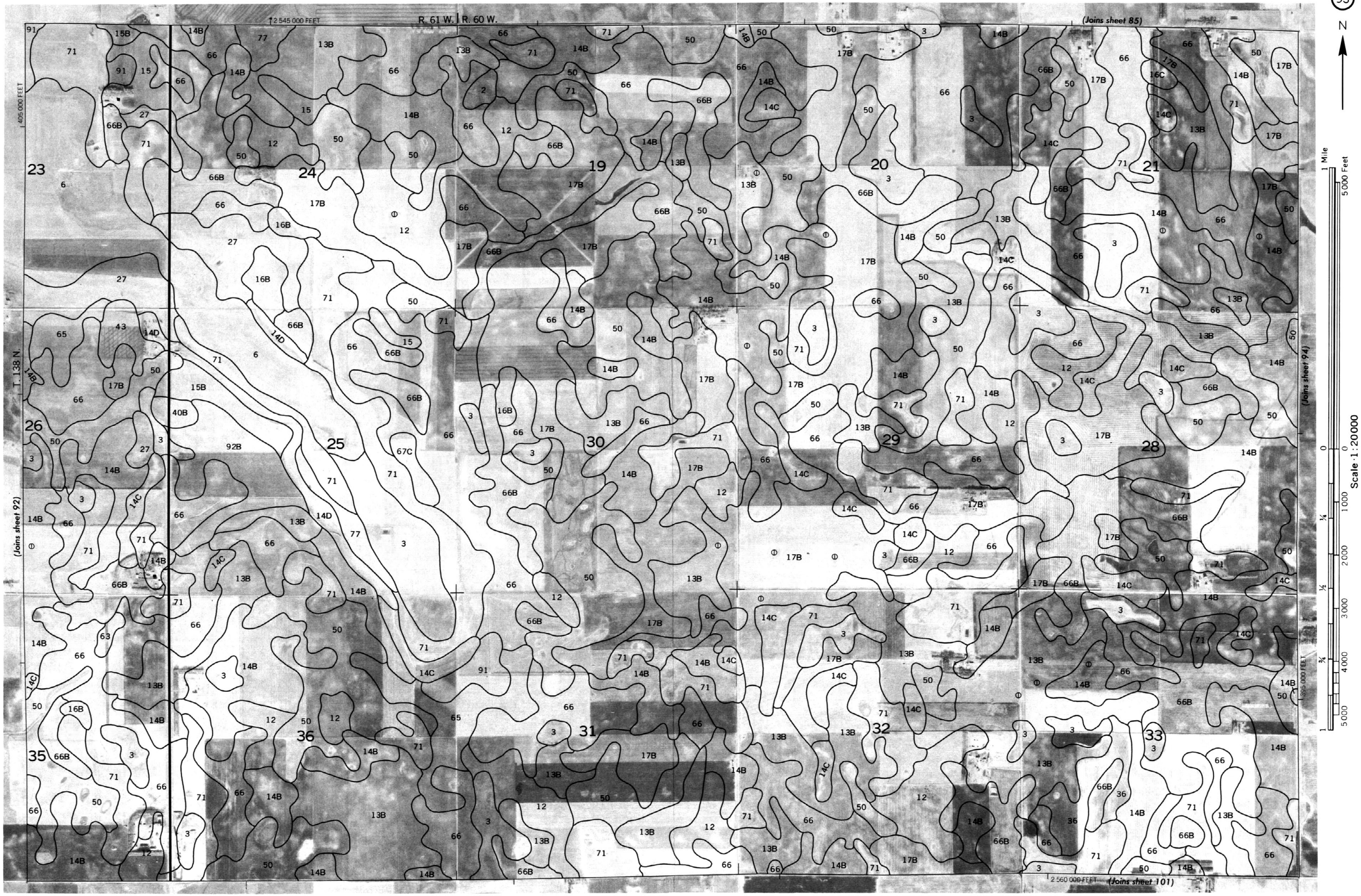
0 1000 2000 3000 4000 5000

0 ¼ ½ ¾ 1



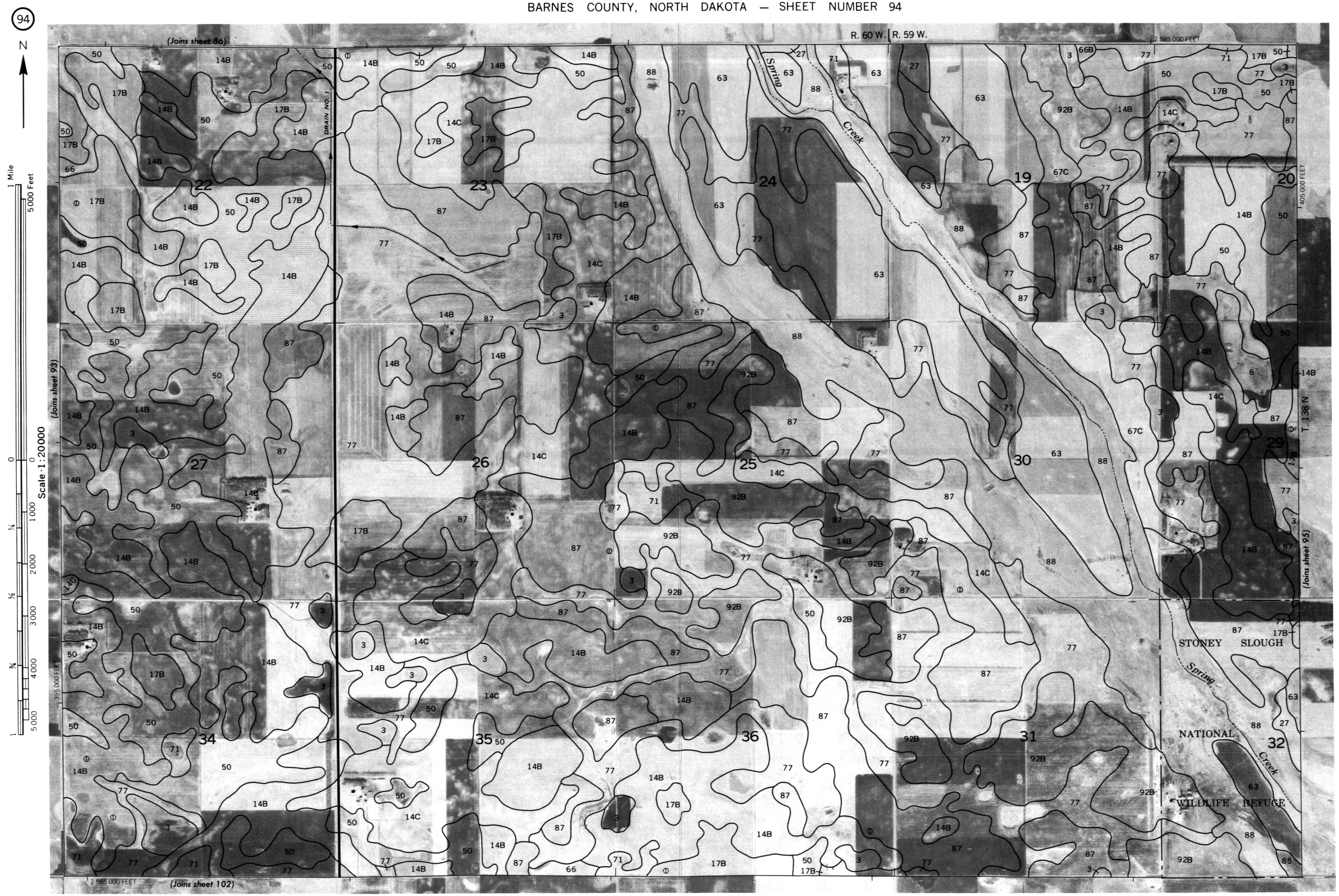
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 92



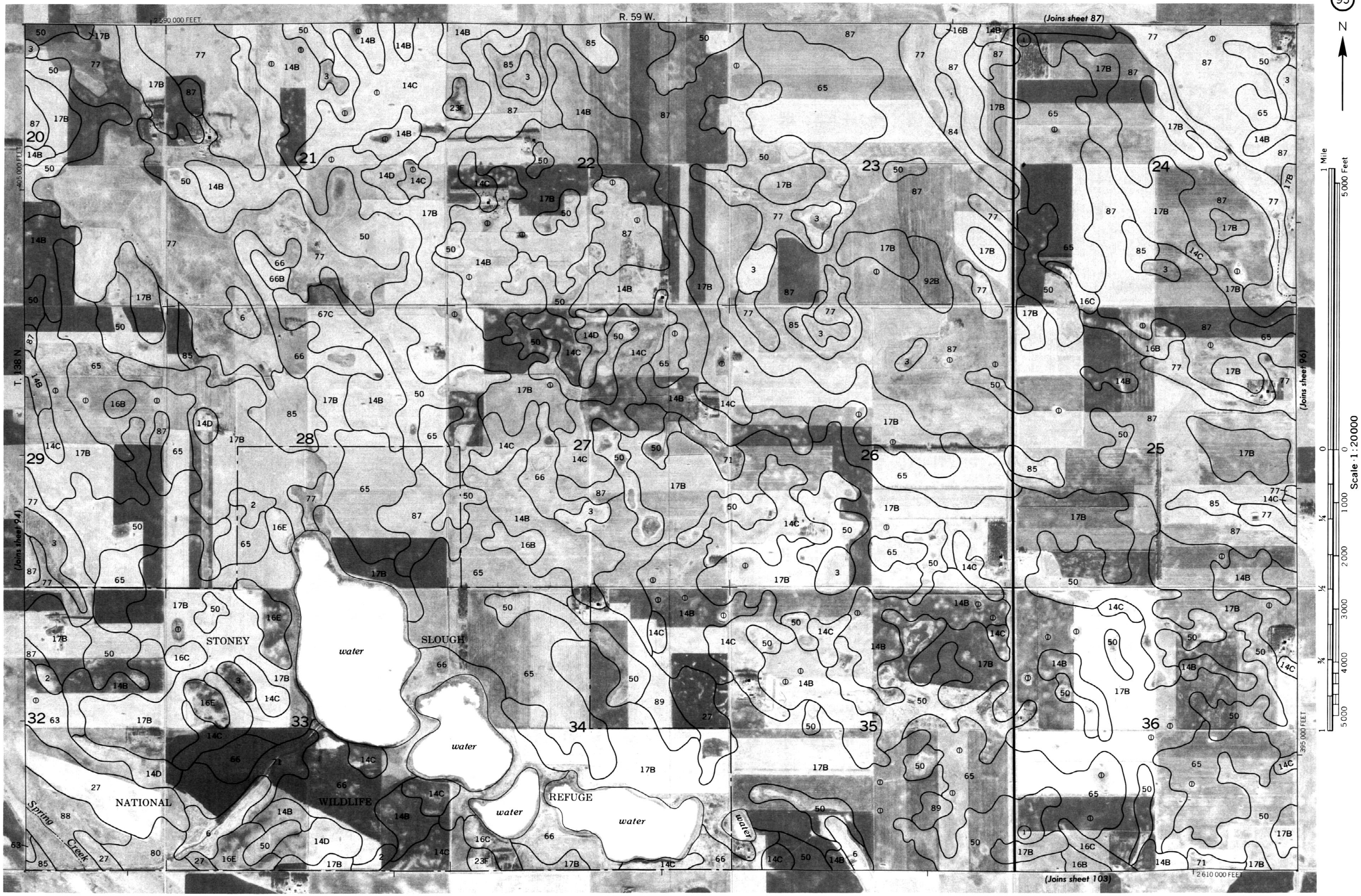
BARNES COUNTY, NORTH DAKOTA NO. 93

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BARNES COUNTY, NORTH DAKOTA NO. 94



BARNES COUNTY, NORTH DAKOTA NO. 95

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

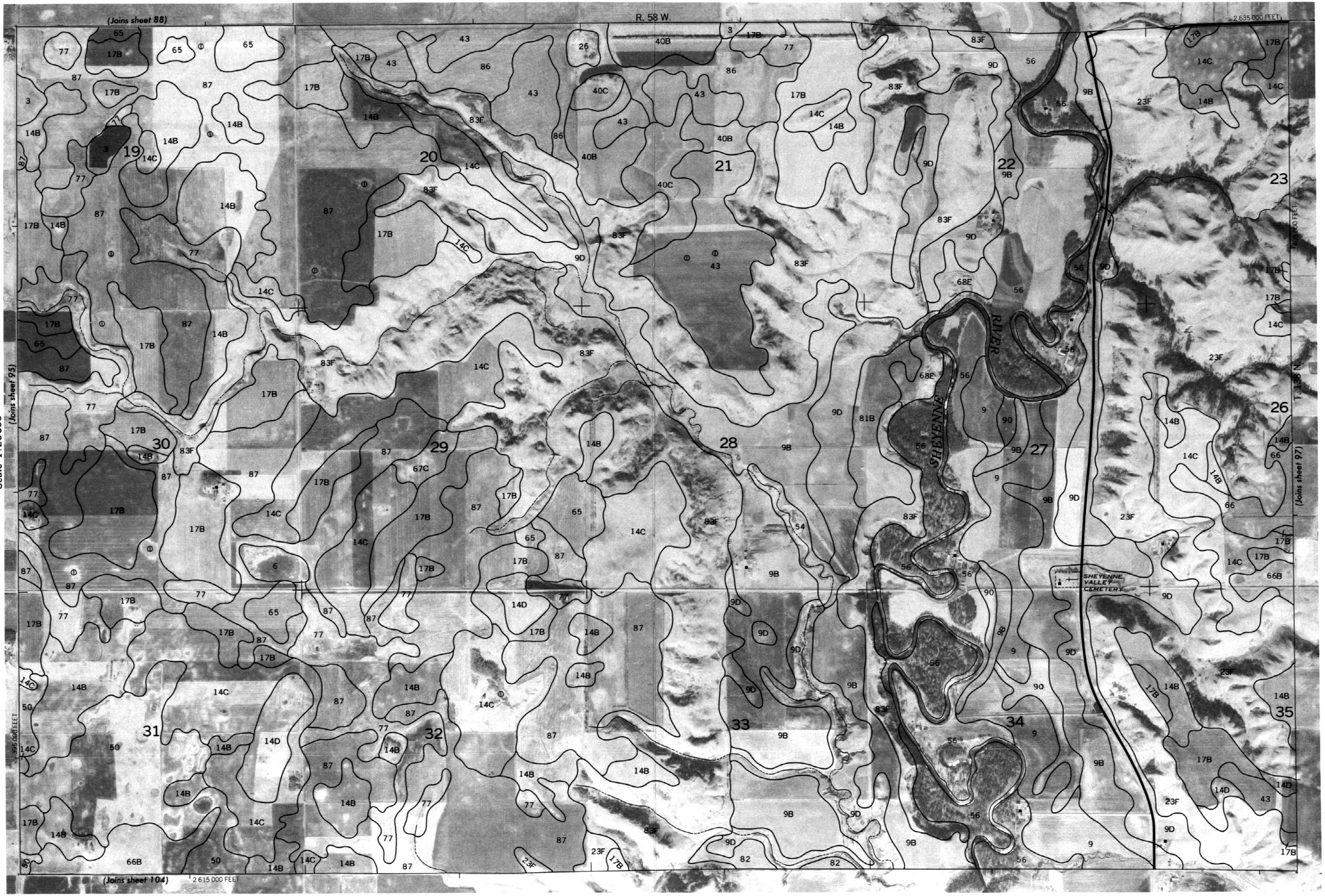
BARNES COUNTY, NORTH DAKOTA — SHEET NUMBER 96

N

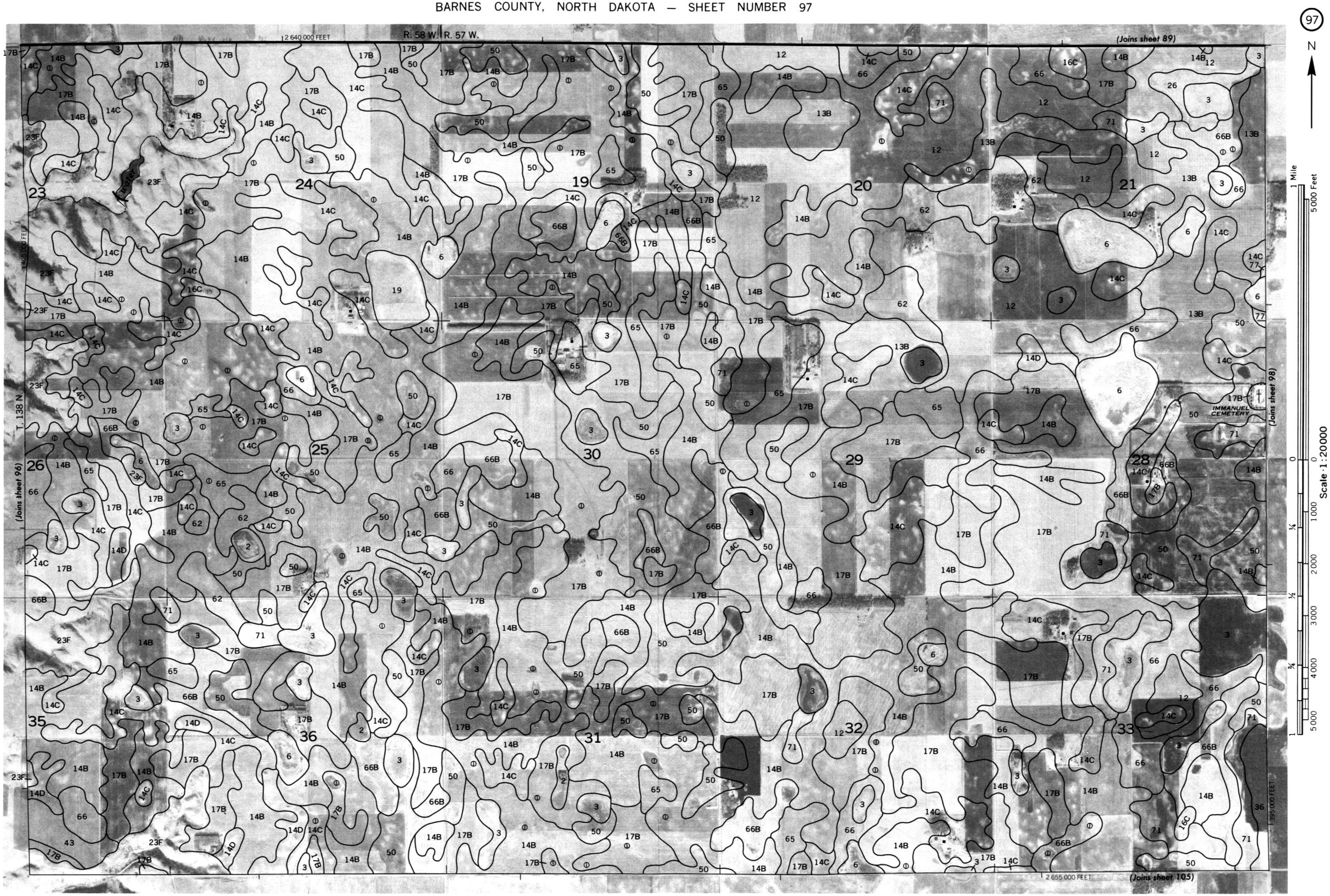
Scale 1:20000

1 Mile

5 000 Feet

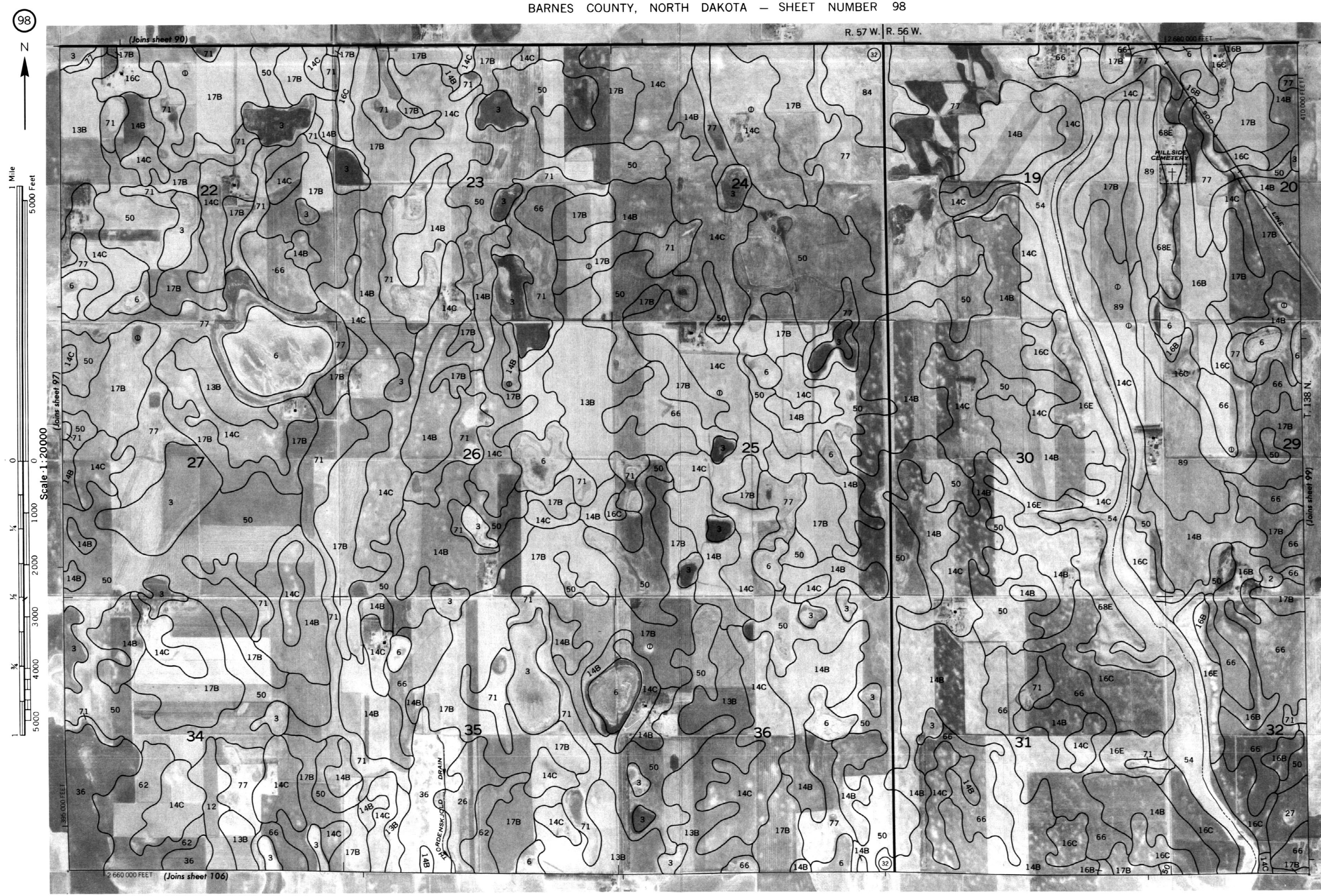


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

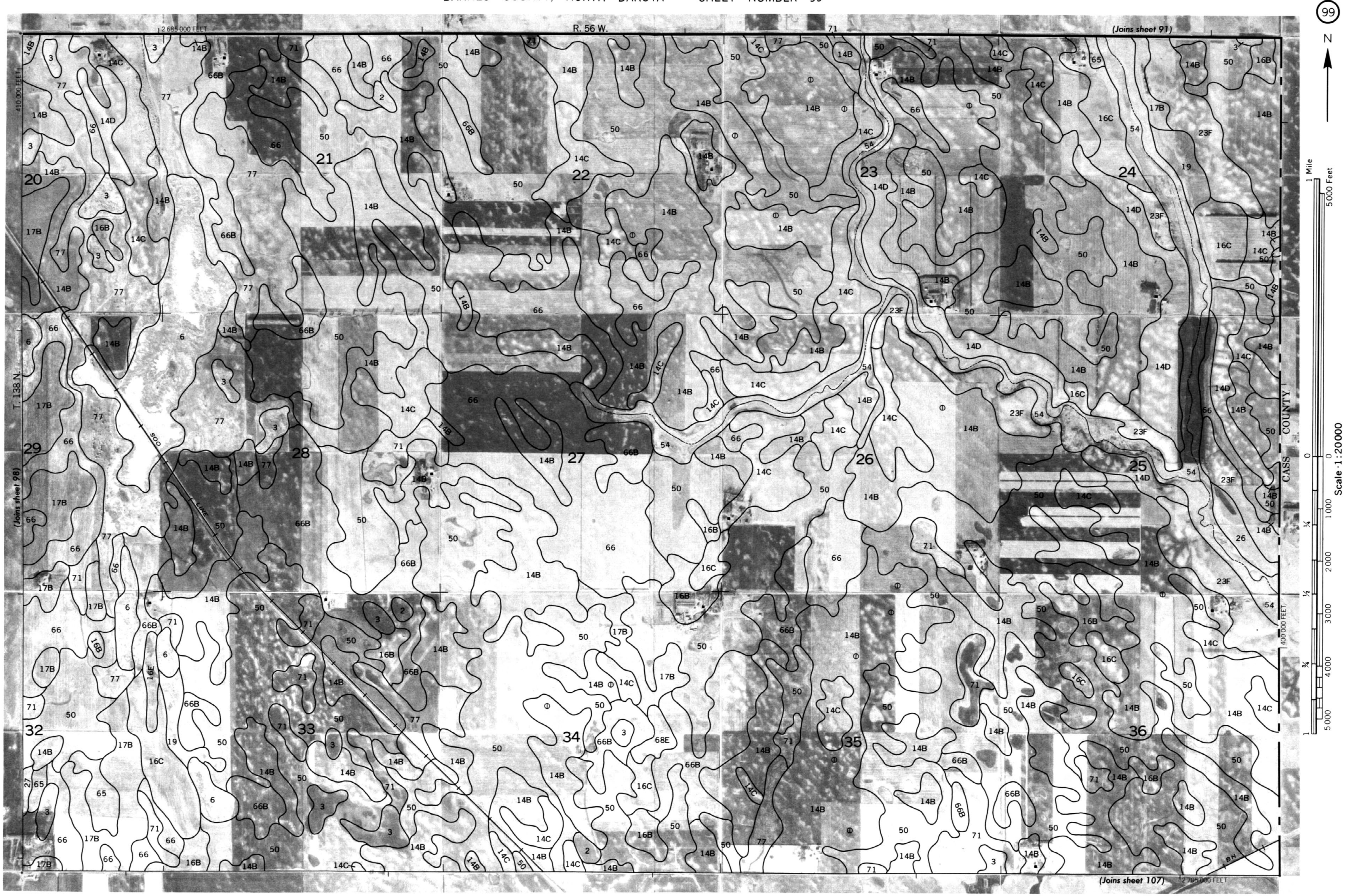


BARNES COUNTY, NORTH DAKOTA NO. 97

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



BARNES COUNTY, NORTH DAKOTA NO. 99

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.